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Osteoid-Osteoma of Bone[1]

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AN OSTEOID-OSTEOMA is a small, oval or roundish, nidus-like benign neoplasm of bone. When well advanced in its evolution, it consists, in varying proportions, of osteoid, trabeculae of newly formed osseous tissue, and a substratum of highly vascularized osteogenic connective tissue. The lesion usually does not exceed a centimeter in its greatest dimension, and in a given affected bone may lie within the spongiosa (perhaps at or near an articular surface), or against the inner surface of the bone cortex, or even actually within the cortex. Though the nidus-like focus is the osteoid-osteoma *per se*, the total abnormal area in the affected bone may be very large, since there may be a perifocal zone of bone thickening or sclerosis extending for a considerable distance beyond the nidus. The lesion is a distinctive one, and we hold that it represents an entity *sui generis* in the pathology of bone disease.

CLINICAL CONSIDERATIONS

To date, we have in our files the data (including roentgenographs and pathologic material) on 62 proved cases, representing, with few exceptions, patients treated in the Hospital for Joint Diseases (New York). Of these 62 cases, 5 formed the basis of our first report (1) on the condition in 1935; 28 represent the cases which accumulated between that time and 1940, when we made our second report (2); the remaining 29 have accumulated during the five succeeding years. It is interesting to note that in general the statistical relations in regard to sex and age incidence and location of the lesions are essentially the same for the total series of 62 cases as for the 33 which had accumulated up to 1940.

Of the total 62 patients, 42 were males and 20 females. There seems now to be little room for doubt that the disorder predilects males.

As to the age incidence, the new cases confirm the finding that osteoid-osteoma has a predilection for adolescents and young adults. We have age records on 59 of the 62 patients. The accompanying table shows the distribution, by five-year

Age	No. of Cases
1 to 5	4
6 to 10	2
11 to 15	15
16 to 20	17
21 to 25	14
26 to 30	5
31 to 35	1
36 and over	1
TOTAL	59

[1] Delivered Feb. 16, 1945, before the New England Roentgen Ray Society and the Boston Orthopedic Club. Accepted for publication in March 1945.

periods, of the ages of these patients at the time of admission for removal of the lesion. The youngest patient was aged a year and a half and the oldest forty-nine years. It is striking that all but 13 of the 59 were between eleven and twenty-four years of age.

The lesion may appear in a limb bone or in one of the bones of the vertebral column, and a clear-cut instance of its occurrence in an innominate bone has been reported (3), though the present writer has not personally encountered it there.[2] Furthermore, it would not be surprising eventually to find it in a skull bone or a rib. The following table lists the various bones affected and, in descending order of frequency, the number of times each was found to be involved among the total 62 cases. As this table also shows, the bones of the lower limbs are much more commonly affected than those of the upper, and in half the cases the lesion was in a tibia or a femur.

Bone Involved	No. of Cases
Tibia	17
Femur	14
Fibula	6
Humerus	5
Vertebrae	4
Astragalus	3
Phalanges (pedal)	3
Phalanges (manual)	2
Ulna	2
Calcaneum	2
Radius	1
Patella	1
Tarsal navicular	1
Ankle region (site not precisely given)	1
TOTAL	62

The duration of complaints at the time of admission for removal of the lesion ranges between a few months and a number of years. Histories of less than six months are the exception; of six months to two years, the rule; and of over two years, not common. Only one patient gave a history of difficulties dating back as long as five years.

Clinically, the principal complaint is of pain, and it was this that consistently led the patients to seek medical attention. Occasional and mild at first, the pain usually increases in persistence and severity and often becomes bad enough to interfere with sleep. Sooner or later, local swelling is apparent in some instances, particularly if the lesion is in a bone site not very thickly covered by soft tissue. Limping is complained of by a considerable number of patients in whom a lower-limb bone is involved. Stiffness and weakness of the part are observed in some cases—notably those in which the lesion is near a joint. In none of our cases was there a history of febrile episodes in connection with the lesion.

Physical examination often reveals a sharply localized point of tenderness somewhere in the painful area. Also, as already noted, there may be some local swelling. These are frequently the only relevant clinical findings. In some cases, on account of the fact that the part has been spared in use, there may also be a slight amount of muscle atrophy. Only rarely does one note even slight local heat and redness and, indeed, these were present in only one of our 62 patients.

A definite majority of the patients (about 70 per cent) did not relate the onset of their complaints to an antecedent local trauma. Some of those who did so relate it stated that the trauma had preceded the onset of symptoms by weeks, months, or even years. The others dated the onset of the complaints directly from the injury. Since, however, only about 30 per cent of the patients brought up the factor of trauma at all, and it was in only about half of these cases that the alleged injury was directly inculpated, we are not inclined to regard trauma as an etiologic factor.

Clinically, the diagnosis of osteoid-osteoma is not very difficult if one is

[2] Since submitting this manuscript for publication, the writer has been afforded the opportunity, through the kindness of Dr. Leo Mayer, of studying personally an osteoid-osteoma which had appeared in an innominate bone of a girl of seventeen and was located just below the anterior inferior spine, extending down almost to the acetabulum.

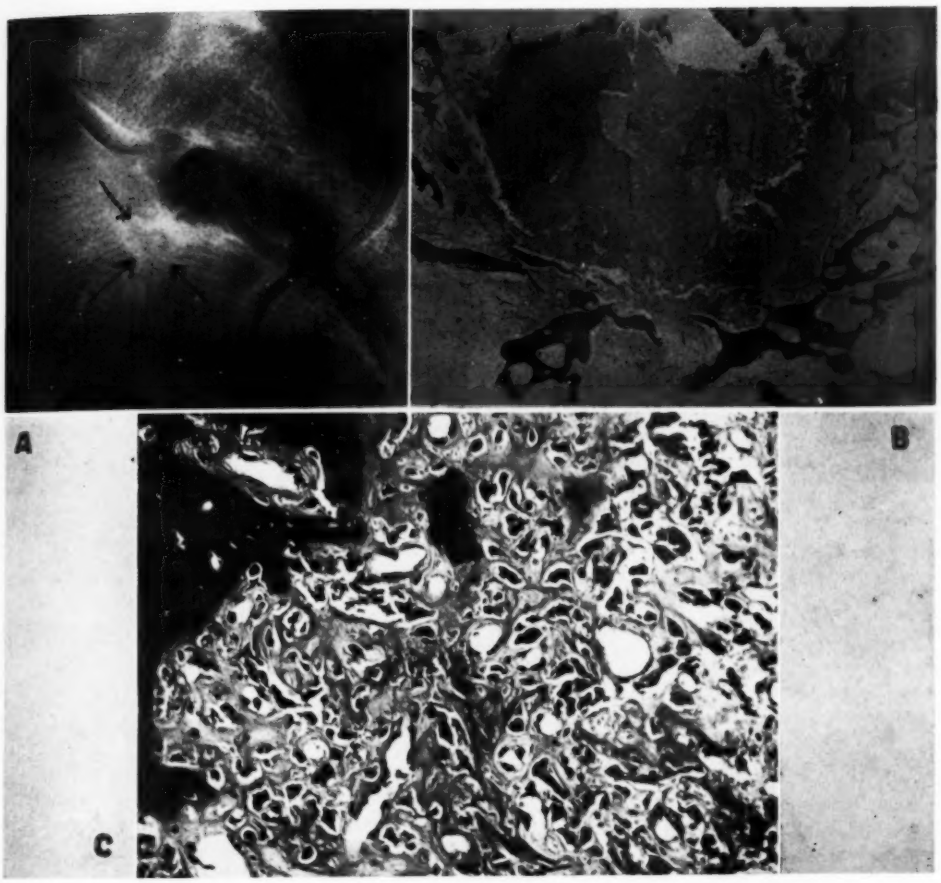

Fig. 1. Case 1. A. Preoperative roentgenograph showing an area of relative radiolucency (corresponding to the osteoid-osteoma) surrounded by an irregular zone of radiopacity. B. Photomicrograph (×10) showing a full cross-section of the osteoid-osteoma standing out clearly against the neighboring bone. The magnification is too low to reveal details of the histologic architecture. C. Photomicrograph (×250) showing cytologic details in one area of the periphery. One can note that the vascular osteoid tissue has undergone bony transformation in some places.

familiar with it, if the possibility of its presence is borne in mind, and if the lesion has advanced sufficiently in its evolution to be demonstrable roentgenographically. The history and physical examination alone often furnish the necessary clues, although it is the roentgenographic picture that constitutes the most valuable single diagnostic guide. In a suspected case presenting a characteristic roentgen picture, the affected bone shows the nidus as a small oval or roundish, relatively radiolucent or (less frequently) radiopaque area. The nidus shadow is often (though by no means regularly) surrounded by a more or less opaque or dense shadow reflecting the reactively thickened or altered zone of neighboring bone. This dense area of perinidal reaction may be only a narrow ring or it may spread for several centimeters about the lesion, even if the latter is in the spongiosa. If the nidus appears in relation to the bone cortex, the reactively densified area may extend for several inches both above and below. The densification of the cortex may also be found to extend for a considerable distance around the circumference of the affected shaft

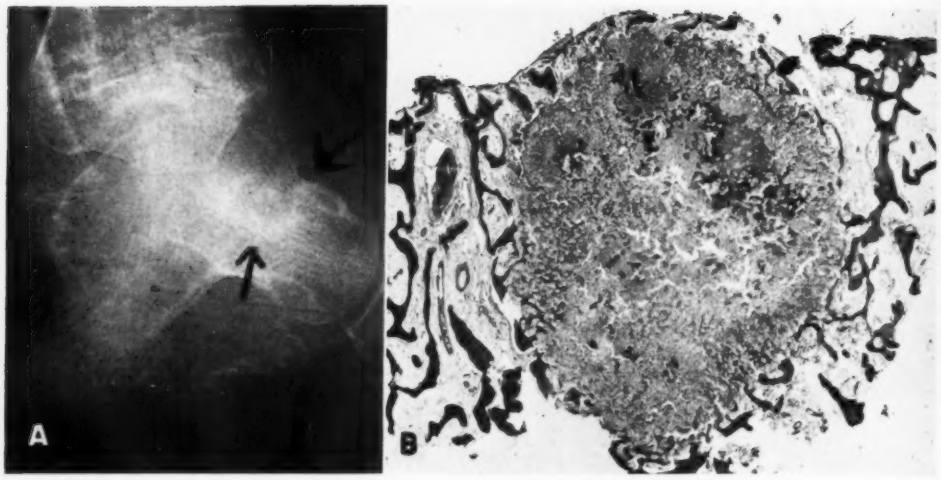

Fig. 2. Case 2. A. Roentgenograph showing the osteoid-osteoma in the neck of the astragalus, as it appeared four months before it was removed surgically. B. Photomicrograph (×10) of the osteoid-osteoma with some of the neighboring bone. Though details of the cytology are not revealed under the low magnification, it is clear even from this picture that the cytologic architecture is not uniform throughout the lesion.

area. Altogether, these are x-ray pictures which the many roentgenologists and orthopedists who accept osteoid-osteoma as a condition *sui generis* have come to know and recognize as representing it. For additional comments on the roentgenographic picture, see p. 326.

Not all cases of osteoid-osteoma, however, are easily recognizable when first coming under medical care. The diagnostic difficulty may be due to the fact that the lesion has not yet evolved sufficiently to be identifiable roentgenographically, or to its obscure location, or to both factors simultaneously. Understanding of the subject can probably best be advanced at this stage by sketches of a number of recent cases which, for one reason or another, presented diagnostic problems.

CASE REPORTS

CASE 1 (Fig. 1): A man of 24, a fourth-year medical student, was admitted to the hospital, under the care of Dr. Leo Mayer. His chief complaint was of pain in the right foot, just anterior to the external malleolus, of sixteen months' duration. He stated that it had begun in August 1940, either before or after he had twisted his right ankle, that at the start it had been only occasional, and that it was aggravated by protracted activity. Two months later, at his school, he first came under medical care for the condition. At that time, the roentgenograph of the ankle region was reported as negative, and the region was strapped. About five months after its onset, the pain began to occur at night, often interfering with sleep. The patient then noticed some swelling of the ankle and severe pain on eversion of the foot. Soon afterward, the pain became continuous, and he began to limp. A short leg plaster with a walking iron was applied, but failed to bring relief. After that, another plaster casing was applied which did not permit weight-bearing, and the patient used a crutch, but again there was no relief. About ten months after onset of the complaints, the foot was again examined roentgenographically and again reported as showing no positive findings. At this time, on the assumption that the patient had a chronic synovitis of the peroneal tendon sheath, the area was explored, but a biopsy specimen taken from the sheath shed no light on the condition.

During the subsequent six months before he consulted Dr. Mayer, the patient began to be regarded as a psychoneurotic. On examination, it was now found that the foot was held in slight internal rotation and slight inversion. There was weakness of the evertors of the foot. The lateral surface of the os calcis, just anterior to the external malleolus, showed slight swelling, and this region was exquisitely sensitive to pressure. There was also tenderness of the os calcis, just anterior to the swelling. The roentgenograph now taken showed a round, somewhat radiolucent nidus about 5 mm. in diameter, surrounded by a narrow perifocal zone of sclerosis and located in the os calcis somewhat below the subastragaloid joint. On removal, the

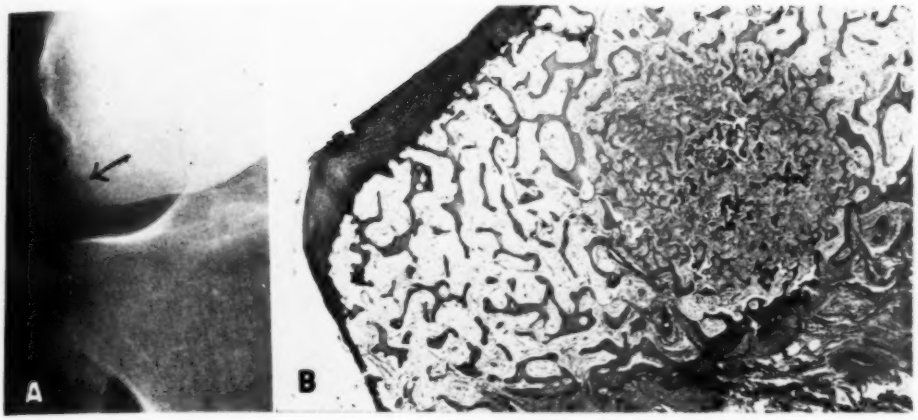

Fig. 3. Case 3. A. Roentgenograph taken the day before the osteoid-osteoma nidus, which now stood out clearly, was removed surgically. B. Photomicrograph (×8) showing a full cross-section of the lesion against the background of surrounding bone. At other levels, the lesion extended to the articular cartilage.

nidus was found to be globular in shape, in part hemorrhagic, and in part yellowish and somewhat gritty. Its removal was followed by prompt, dramatic, and permanent relief from all the local complaints, as was reported by Dr. L. J. Barron (4) in the *Bulletin of the Hospital for Joint Diseases*.

CASE 2 (Fig. 2): A boy of 11 was admitted to the hospital, under the care of Dr. Samuel Kleinberg. His complaint, which was of pain and disability relating to the left ankle region, was then of one and a half year's duration, dating back to July 1942. The onset of his difficulty was rather sudden and was not preceded by any known trauma. Two months afterward, the patient first consulted Dr. Kleinberg, who, on the basis of the history and physical examination, suspected even then that an osteoid-osteoma was present in the astragalus, though the roentgenographic findings at that time were equivocal. Shortly thereafter, the patient was transferred to the care of another orthopedic hospital. There it was suspected that he was suffering from tuberculosis of the astragalus, in the vicinity of the astragalo-calcaneal joint. The area in question was explored, but nothing significant was found. Some synovium was taken for histologic examination but yielded no positive findings. The foot was then kept in a brace for about six months, but there was no subsidence of the complaints. About fifteen months after the onset of symptoms, a roentgenograph clearly revealed, for the first time, a lesion considered to be an osteoid-osteoma, which, however, was located in the superior portion of the neck of the astragalus. Nevertheless, the foot was kept in a plaster-of-Paris bandage for an additional four months, still without subsidence of the complaints. The patient was then returned to the care of Dr. Kleinberg.

Examination just prior to surgical intervention for the osteoid-osteoma showed that the ankle region was much swollen and that there was considerable tenderness to pressure over the anterior aspect of the foot in the region of the astragalus. Also, the bones of the foot were extremely atrophic on account of the protracted immobilization. Motions of the ankle were painful and restricted, and the patient favored the area very much in walking. At operation, the diseased area in the neck of the astragalus was resected in one block, measuring 1.5 × 1.5 cm. and up to 1 cm. in thickness. On its upper surface, the block presented a round, slightly elevated, reddishly discolored area measuring 1 cm. in diameter. On transection, the nidus was clearly seen as a globular mass about 1 cm. in diameter, in part reddish and in part whitish and calcareous, surrounded by a small rim of spongiosa. The excision was immediately followed by complete subsidence of the local complaints.

CASE 3 (Fig. 3): A woman 49 years of age, admitted to the hospital under the care of Dr. Kleinberg, stated that she had had pain in the left knee for the past two years, specifically since about November 1938. It had begun insidiously, without any known antecedent injury or illness. It was mild and intermittent at first, but soon became continuous and severe, causing disability and interfering with sleep. It was only on the day before admission that the patient first consulted Dr. Kleinberg. She told him that in the previous two years roentgenographs of the knee had been made many times and that its condition had been diagnosed as arthritis. Indeed, many teeth had been extracted on the assumption that root infections were responsible for the articular difficulty.

In his study of the patient, Dr. Kleinberg found

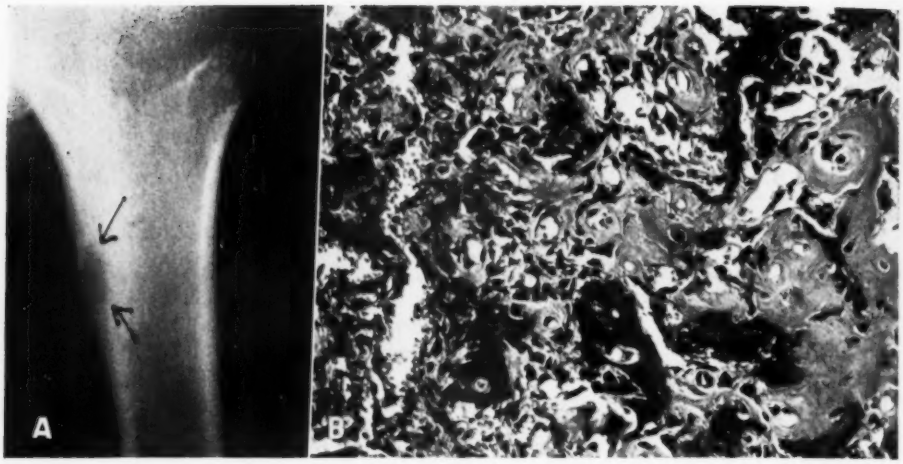

Fig. 4. Case 4. A. Preoperative roentgenograph showing the osteoid-osteoma nidus in the upper end of the cortex of the humerus, on the medial side. B. Photomicrograph (×250) showing tissue from the osteoid-osteoma which was sectioned without decalcification. Note the vascular osteogenic connective-tissue substratum, containing osteoid which is undergoing calcification and thus bony transformation in some places.

that she walked with a limp on the left side, but that the knee was freely movable and showed no local heat or excessive articular fluid. The circumference of the calf was an inch less on the affected leg than on the other. The patient pointed to one spot on the antero-external surface of the lower end of the femur as the center of the pain, and at this site there was exquisite tenderness to pressure, limited to an area about 1/2 inch square. The presence of an osteoid-osteoma was suspected. A roentgenograph taken on admission to the hospital showed a nidus-like focus of abnormality at the lateral margin of the external condyle, extending almost to the articular cartilage. Restudy of the roentgenographs which had been taken elsewhere during the preceding two years showed, in some, an analogous abnormal focus, which, however, because of its lack of conspicuousness, might easily have been overlooked.

The area in question, with some of the neighboring bone, was excised in one block. This consisted of a small wedge of the external condyle of the femur, lined on one surface by a bit of articular cartilage, beyond which the cortex continued. Shining through the periosteum, in the vicinity of the cartilage-cortex junction, was a basically gray, reddishly discolored nidus-like area, oval in shape and about 7 mm. in its greatest diameter, which bulged the periosteum and was located in the spongiosa. Removal of the osteoid-osteoma was promptly followed by relief from all the difficulties, as Dr. Kleinberg notes in his account of this case (5).

CASE 4 (Fig. 4): A girl 20 years of age was admitted to the hospital, under the care of Dr. Harry Sonnenschein. She stated that for the past two years (since about December 1941) she had been having pain in the upper part of the right arm and shoulder region, and that, though there was no pain in the elbow, there was also pain in the forearm and wrist, down to the base of the fingers. The pain was dull, nagging in character, constantly present, and definitely worse at night, but was not affected by activity or by changes in the weather. It usually yielded to aspirin but was sometimes so severe that morphine was needed for relief. The patient also stated that the right hand had been perspiring more than the left and that occasionally she felt a sensation of coldness in the hand in question. However, there were no differences between the two hands in respect to skin color or temperature. Also, there was a full range of painless motion in all the joints.

Though the sweating of the hand was held to be incompatible with a scalenus anticus syndrome, the clinical impression created by the case as a whole was that the complaints had a neurological basis. The patient was seen by two neurologists, neither of whom found anything to sustain the diagnosis of a scalenus anticus syndrome. Note was taken, however, of wasting of the right supraspinatus and infraspinatus and anterior serratus muscles. One of the neurologists obtained the impression that the complaints might be related to an occupational neurosis; the other suggested spinal-fluid studies to determine the possibility of a cord lesion.

Roentgenographic studies of the chest, cervical spine, and right shoulder girdle were all negative except in regard to the upper portion of the shaft of the right humerus. There it was noted that the cortex, somewhat below the neck of the humerus, on one side was thickened and sclerotic and pre-

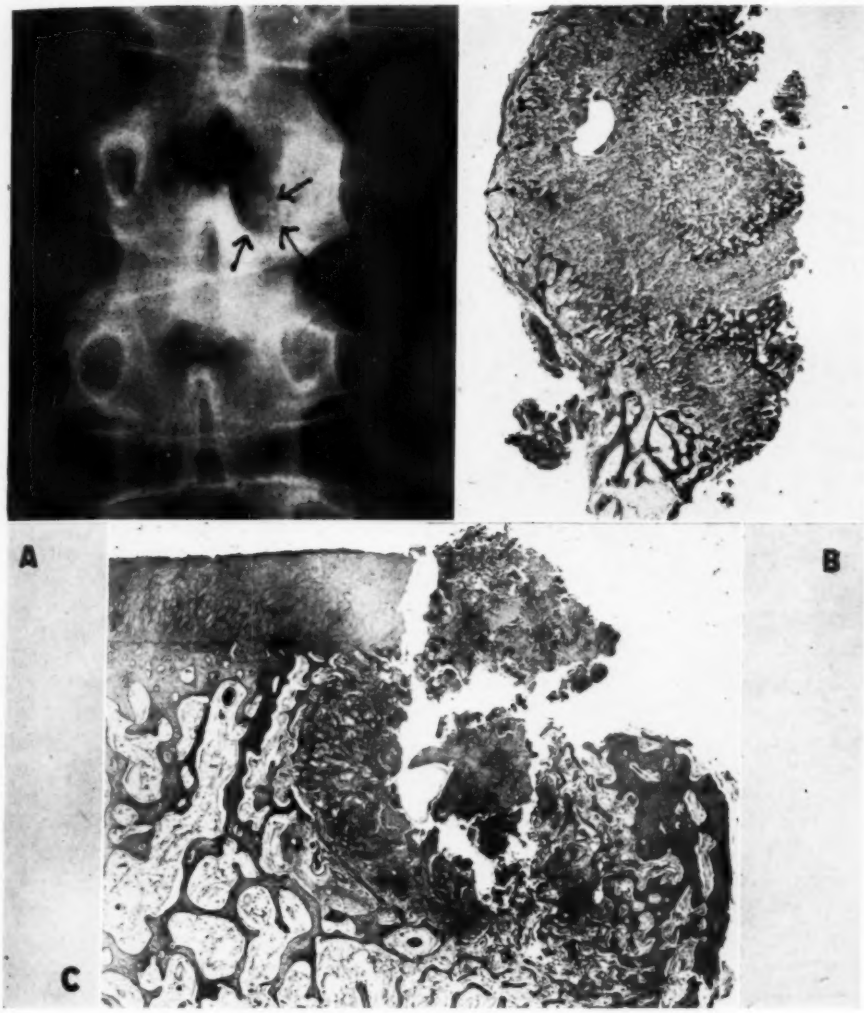

Fig. 5. A. Roentgenograph showing the osteoid-osteoma nidus on the right side of the second lumbar vertebra in Case 5. The lesion was in the isthmus, between the ascending and descending facets. B. Photomicrograph (×10) showing part of the lesional tissue that was removed. This represents a cross-section of about half of the lesion, which broke in the course of its removal. C. Photomicrograph (×10) from another case of osteoid-osteoma in a vertebra. Specifically, the lesion was located in the left descending facet of the second lumbar vertebra, and the illustration shows how clearly the lesional tissue stands out from the unaffected bone area.

sented an oval-shaped focus of relative radiolucency about 1 cm. in its longest axis. Because this was the only abnormality ascertainable, the area was saucerized and the material sent to the laboratory. Among the many pieces of cortical and spongy bone received, were two bits of gritty, brownish tissue which, on histologic examination, were found to be parts of an osteoid-osteoma nidus. The intervention promptly relieved the patient of her pain, and within a few days all the complaints for which she entered the hospital had subsided, not to recur.

CASE 5 (Fig. 5): A girl of 10 was admitted to the hospital, under the care of Dr. Samuel Kleinberg. For ten months (since August 1942) the child had had pain in the back. Previously, she had been under care at another hospital, where she was treated first with exercises, then with traction on a convex frame, and finally by encasement in plaster of Paris. Examination on admission here revealed a mild, rounded fullness of the paravertebral region on the right side, at the level of the 1st and 2d lumbar vertebrae. Though palpation did not elicit any

tenderness over the spinous processes of these vertebrae, there was exquisite tenderness just to the right of the mid-line in this region. A roentgenograph taken on admission revealed a small area of abnormality involving the upper aspect of the lamina of the 2d lumbar vertebra on the right side. Though no definitive preoperative diagnosis had been made, exploration seemed advisable. At the site in question, the surgeon found a globular, red, partly soft and partly calcareous, cherry-sized focus of tissue, which was removed with part of the lamina from which it sprang. On examination in the laboratory this nidus-like focus was found to measure 7 mm. in its greatest diameter, and bits of similar tissue were found lining excavations of osseous fragments, representing parts of the lamina. Removal of the lesion (and local spinal fusion) was followed by disappearance of the complaints, which have not recurred to date.

COURSE IF THE OSTEOID-OSTEOMA NIDUS IS MISSED ON SURGICAL INTERVENTION

That the associated clinical complaints promptly and permanently cease when an osteoid-osteoma is removed, is illustrated by the cases we have just cited and by our total experience with the lesion. On the other hand, we know that if, in the course of the operation, the osteoid-osteoma is not removed or destroyed, the clinical complaints do not disappear. Two cases will suffice to illustrate this fact, one showing continuance and the other subsequent renewal of the complaints following the intervention.

The former patient was a man of 24, and the total period of complaint was four years at the time of admission to our hospital on account of an osteoid-osteoma of the shaft of the femur. Two years previously he had been operated upon at another hospital for what was believed to be an osteomyelitis at the same site, but, though some thickened cortex was removed, the nidus was not. The complaints continued after the operation and, indeed, were even more pronounced than before. They disappeared promptly and completely after the second surgical intervention, two years later, at which time the osteoid-osteoma nidus was removed.

In the other case—that of a boy of 13 years—the complaints were of six months' duration at the time of initial admission, and the osteoid-osteoma was in the neck of the femur, adjacent to the lesser trochanter. The surgeon attempted a block resection, hoping to remove the nidus intact in its setting. Unfortunately, as was revealed by anatomic examination of the specimen and by a postoperative roentgenogram, the nidus was left behind. The patient was free of complaints for about twelve months, but was readmitted about two months later (that is, about fourteen months after the first admission) with essentially the same complaints he had had originally. At this time, the osteoid-osteoma nidus was really removed, and at the last follow-up, a year and a half after the second intervention, the patient was still free of his osteoid-osteoma complaints (Fig. 6).

PROBLEMS OF ROENTGENOGRAPHIC DIAGNOSIS

As already noted, it is roentgenographic study that constitutes the most valuable aid in the clinical diagnosis of osteoid-osteoma. Nevertheless, the diagnosis may present certain difficulties, even in cases in which the complaints are of long standing. Thus, if the affected bone area is much thickened, the nidus may fail to stand out against the surrounding bone if insufficient kilovoltage is used in the exposure of the film. This was found to be particularly true in a number of cases in which the lesion was related to the cortex of a long bone. Under ordinary conditions of exposure, all one noted was blurry thickening of the affected bone area. However, when the field had been coned down upon, and the picture had been taken with a good deal of overexposure and in different planes, the osteoid-osteoma nidus stood out clearly.

In cases in which the complaints are of recent date, it may be difficult to demonstrate the osteoid-osteoma nidus even under favorable technical conditions. This probably explains, in part, why the large majority of the patients under consideration did not enter the hospital for removal of the lesion until a year or more after

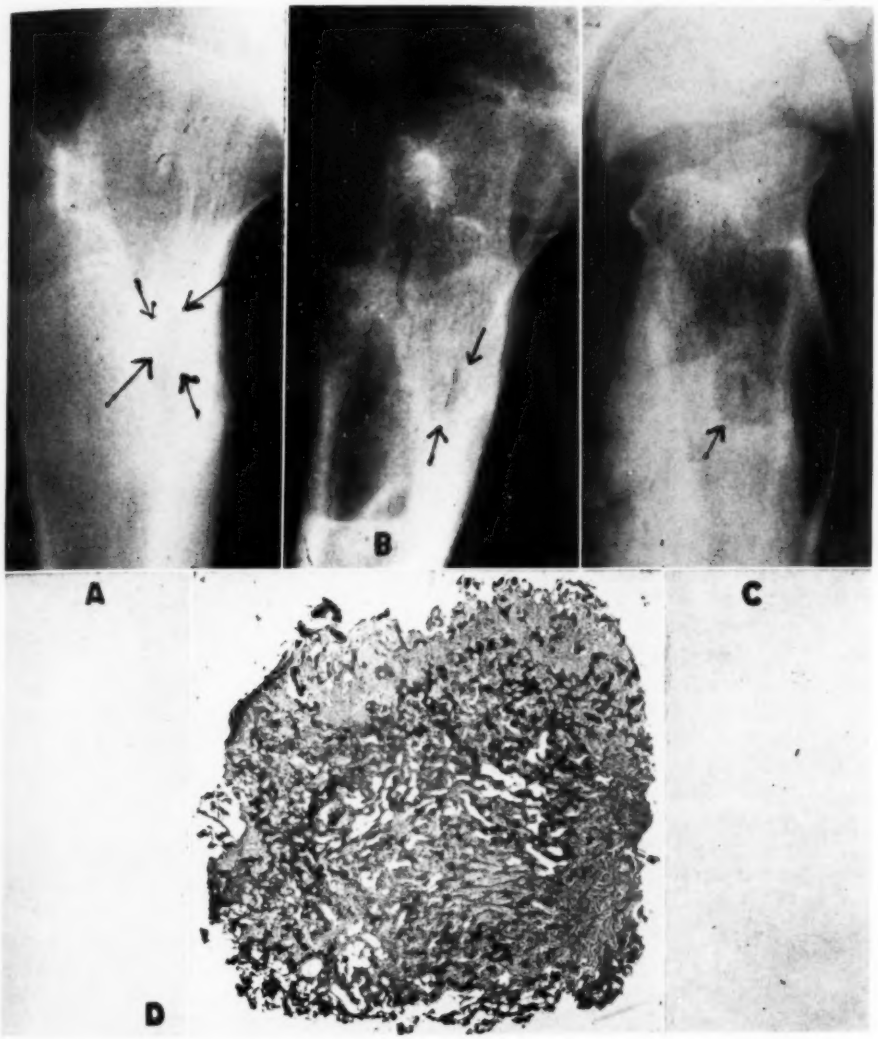

Fig. 6. Case in a boy of 13, in which the osteoid-osteoma nidus was not removed at the first operation. A. Preoperative roentgenograph, showing, though indistinctly, the lesion in the neck of the femur, adjacent to the lesser trochanter. B. Roentgenograph taken shortly after the operative intervention, showing that the block of bone resected did not include the osteoid-osteoma, the latter now showing up much more distinctly than before. C. Roentgenograph taken fourteen months after the original surgical intervention—that is, just prior to the second surgical intervention for removal of the nidus. D. Photomicrograph (×13) showing a cross-section of the osteoid-osteoma nidus that was removed at the second operation

the onset of their complaints. Indeed, in many of these cases, roentgenographic examination of the painful bone area had been done previously (usually elsewhere) but failed to yield any illuminating findings, and it was only the picture taken shortly before admission that revealed the lesion. Thus, in a suspected case not confirmed by the original x-ray examination, re-examination should be done at intervals of a few months, since it may ultimately confirm the diagnosis, as it did in some of our series.

In respect to the shadow cast by the

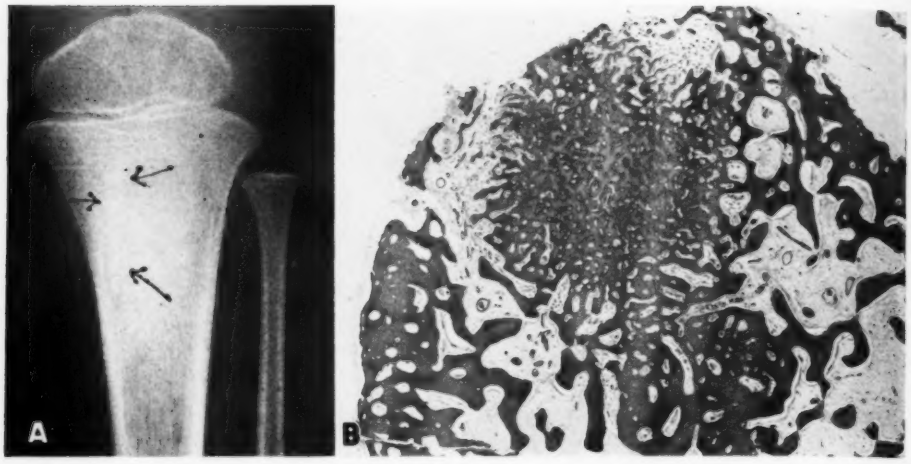

Fig. 7. A. Roentgenograph of an osteoid-osteoma in an early stage of evolution, developing in the cortex of a tibia posteriorly. The patient was a child of 2 1/2 years who complained of pain below the knee for only three months before admission to the hospital. An osteoid-osteoma evolving in the cortex of a bone and presenting this roentgenographic appearance (not observed until recently and hence not illustrated in the previous articles) was noted also in 2 other of our cases, in which the lesion was also held to be in a very early stage of evolution. B. Photomicrograph (×10) showing a cross-section through the lesion. Note the sharp delimitation of the latter from the surrounding cortex.

osteoid-osteoma nidus at various stages of its evolution—that is, in respect to its relative radiolucency or radiopacity in relation to the bone neighboring upon it—the author's opinion has undergone a change which calls for comment. Previously (2), it was stated that an osteoid-osteoma nidus which appeared relatively radiolucent represented the lesion in an early stage of its evolution, and a nidus which appeared relatively opaque represented a late stage of evolution. On the basis of further experience and recorrelation of the anatomic with the roentgenographic findings in all of our material, the opposite seems to be nearer the fact. Thus, we now believe that when an osteoid-osteoma nidus appears as a relatively radiolucent round or oval area surrounded by a zone of radiopacity, the lesion is likely to be one which has reached its fullest development, while in the earlier stage of its evolution the nidus tends to cast a relatively radiopaque shadow.

If one is dealing with a nidus in an early stage, especially if the surrounding bone has undergone thickening or sclerosis, the two shadows may even merge and be indistinguishable, and the difficulty of diagnosis of some of the cases while still in an early stage of evolution may stem from this fact. On the other hand, if one is dealing with a nidus in the early stage of its evolution but the surrounding bone has not undergone much sclerosis, the nidus may stand our clearly as a focus of radiopacity. We have seen 3 cases of this kind in which the evolving early lesion was etched out with striking clarity as a small rod-shaped focus against the neighboring bone (Fig. 7).

DIFFERENTIAL DIAGNOSIS

There is no doubt that cases of osteoid-osteoma are still often interpreted as localized bone infection, and specifically as Brodie's abscess, intracortical bone abscess, or even the so-called "sclerosing non-suppurating osteomyelitis of Garré." Indeed, in a paper entitled "Solitary Eccentric (Cortical) Abscess in Bone," published in the October 1943 issue of *Surgery*, Brown and Ghormley (6) reject the concept of osteoid-osteoma. They maintain in particular that the lesions of the kind which we would call osteoid-osteomas

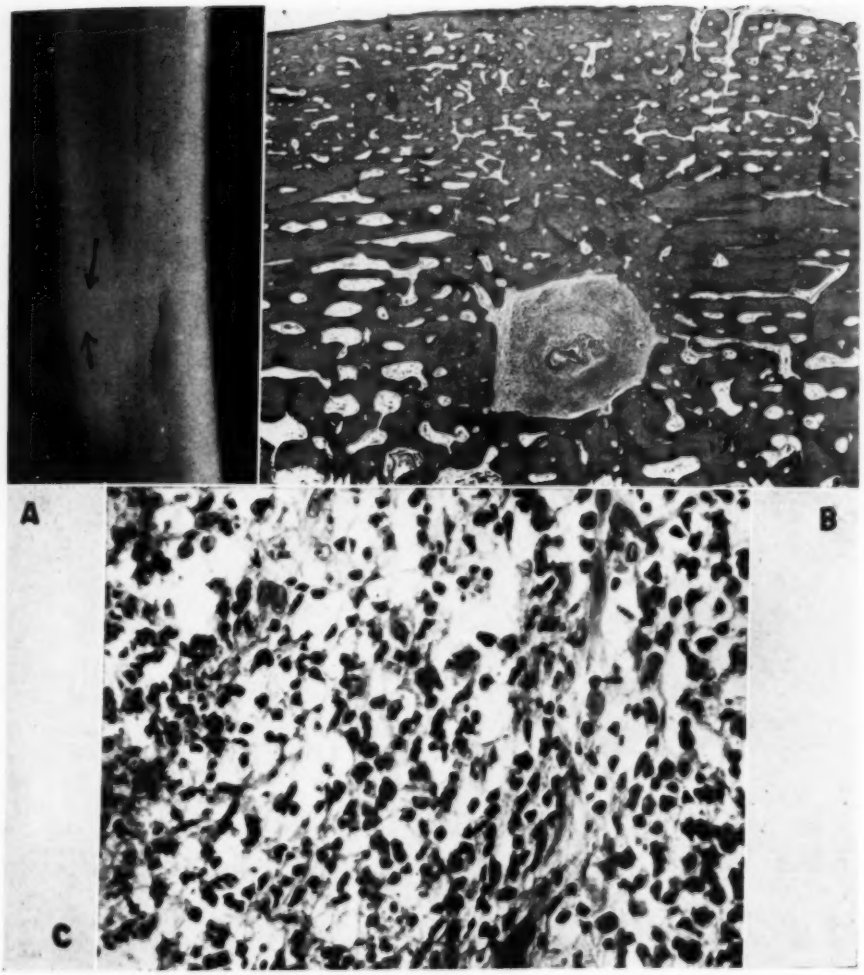

Fig. 8. Case 1A. A. Preoperative roentgenograph of the tibia of a woman of 42 who was suffering from an intracortical bone abscess. From the x-ray picture and from the clinical findings one might have suspected an osteoid-osteoma, but the clinical history was not characteristic of the latter lesion. B. Photomicrograph (×8) showing a full cross-section of the abscess, which is located in the interior of the original cortical bone. The thickening of the cortex is due to periosteal new bone apposition. C. Photomicrograph (×250) showing the abscess wall heavily infiltrated with polymorphonuclear leukocytes.

oriented to the cortex of the affected bone are nothing more than solitary cortical bone abscesses. They also imply that lesions which we would call osteoid-osteomas oriented to the spongiosa of a bone are nothing more than solitary medullary abscesses (*i.e.*, Brodie abscesses).

Study of their paper, however, shows the following: In the first place, of their 24 cases, supposedly of solitary bone abscess, only 14 came to surgery and were hence susceptible to anatomic confirmation. Furthermore, while the roentgenographic picture is given in 6 cases (4 of which I would accept as probable instances of osteoid-osteoma on the basis of the picture) none of the 3 photomicrographs given relates to any of these 6 cases. In addition, of the 3 photomicrographs, only 1 presents a picture clear enough to be

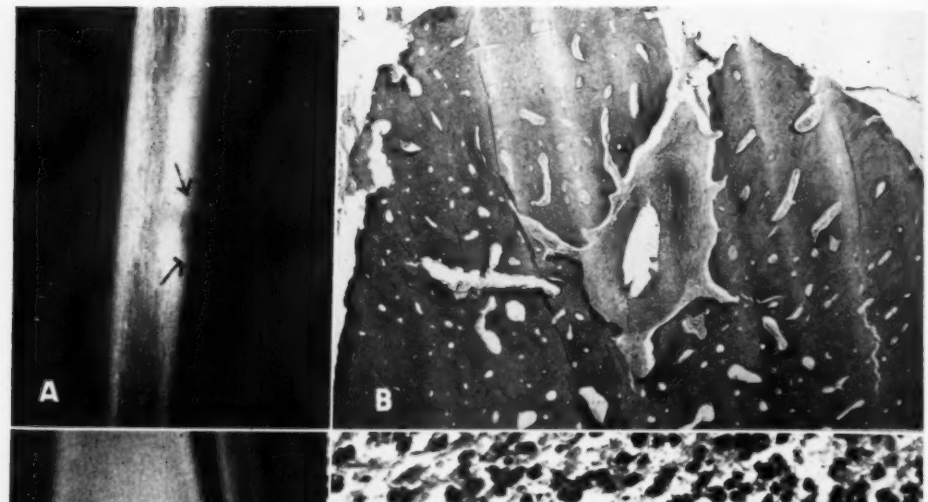

Fig. 9. Cases 2A and 3A. A. Roentgenograph of a fibula of a girl of 21, showing an intracortical abscess (Case 2A). In this case, neither the clinical history nor the clinical findings could support a diagnosis of osteoid-osteoma. B. Photomicrograph (×10) showing, in the cortex of the fibula, the abscess which is extending to the surface of the bone and which is lined by a thick connective-tissue membrane found to be heavily infiltrated by leukocytes. C. Roentgenograph showing a lesion in the lower metaphysis of a tibia of a boy of 13 (Case 3A) who was admitted for treatment of a solitary intramedullary bone abscess (Brodie abscess). In this case, neither the roentgenographic findings nor the history and clinical findings would support a diagnosis of osteoid-osteoma. D. Photomicrograph (×250) showing the character of the granulation tissue occupying the interior of the abscess cavity in this case.

confidently interpreted at all on a pathologic basis. That picture plainly shows evidences of rather acute infection, and though, as already stated, the x-ray picture in this case is not given, one can be satisfied, with the aid of the legend, that the authors were dealing in that instance with a bone abscess rather than an osteoid-osteoma.

That localized bone abscesses exist, the writer has never denied. These abscesses may be purely intracortical, they may be intracortical and subperiosteal, or intracortical and medullary, or they may be purely medullary. In anatomic appearance, they bear no resemblance whatever to the osteoid-osteoma lesion. Clinically, too, most examples of solitary bone abscess (cortical or intramedullary) bear little resemblance to cases of osteoid-osteoma, though roentgenographically a solitary bone abscess sometimes resembles an osteoid-osteoma. Indeed, it is purely because a cortical bone abscess may re-

semble roentgenographically an osteoid-osteoma with cortical orientation, that Brailsford (7) interprets the latter as a chronic subperiosteal abscess.

I shall now present 3 cases of bone abscess in which the anatomic findings, especially, speak for themselves as to the difference of this lesion from osteoid-osteoma.

CASE 1A (Fig. 8): The patient was a woman of 42, complaining of attacks of dull, aching pain in the middle of the right leg, appearing at night and lasting only until morning. These had been noted at monthly or bimonthly intervals for the past two years, especially. The anterior surface of the middle of the tibia was thickened over a small area, but the overlying skin was not adherent, abnormally warm, or reddened.

CASE 2A (Fig. 9, A and B): A girl of 21 complained of localized swelling, of three weeks' duration, on the outer aspect of the left leg. Trouble with this leg had begun about a year before, when apparently a bite or scratch had become infected. In the interim, however, the manifestations of acute local infection had subsided, and now all that was apparent clinically was the swelling associated with thickening of the soft tissues over the middle region of the fibula.

CASE 3A (Fig. 9, C and D): A boy of 13 was admitted because of sudden exacerbation of pain and swelling of the right ankle, which had been noticed from time to time during the past two years. The ankle region was swollen, tender, and warm, and the clinical impression was that the condition was a bone abscess.

Another source of diagnostic difficulty may arise under the following circumstances: A patient may have pain localized to some bone or joint area in which roentgenographic examination reveals a focus of radiopacity suggesting an enostosis. In such a case, there is danger that the enostosis may be misinterpreted as an osteoid-osteoma and believed erroneously to be the source of the pain. The speaker has seen several cases in which this situation created a practical problem of differential diagnosis. The absence of sclerosis or thickening of the bone about the enostosis, and of point tenderness over it, should help to distinguish it from an osteoid-osteoma.

Finally, in the course of roentgenographic study of a joint area, one may encounter in one of the constituent bones a small focus of radiolucency which may superficially suggest an osteoid-osteoma and mistakenly be held responsible for complaints, but which actually represents merely a small, nondescript fibrous nodule or even a cyst in the bone, the complaints having some other cause.

THE NATURE AND GENESIS OF OSTEOID-OSTEOMA

On the basis of the additional experience we have had with osteoid-osteoma since 1940, the writer still feels full confidence in affirming that this lesion of bone is a lesion *sui generis*. As to the reaction of others to this conception, it must be said in advance that only a meager literature has accumulated on the subject. The authors of the relevant reports fall into three main groups in respect to their opinions about the lesion. There are those, including Mallory (8), Stauffer (9), Lewis (3), Bado and Larghero-Ibarz (10), and our colleagues, Kleinberg (5), Horwitz (11), and Barron (4), who accept our concept of osteoid-osteoma. Others, including Mondolfo (12), Ottolenghi (13), and Brailsford (7), though recognizing the anatomic distinctiveness of the lesion, nevertheless interpret it as representing a peculiar inflammatory tissue reaction in a bone, rather than a small, self-limiting neoformation, in accordance with our conception. Finally, there are Brown and Ghormley (6), who deny the distinctiveness of the lesion altogether and maintain that all so-called osteoid-osteoma lesions are only small chronic bone abscesses oriented either to the cortex or to the spongiosa of the affected bone.

Just as strongly as we have maintained that osteoid-osteoma is a lesion *sui generis* we have maintained that it cannot be held to have an inflammatory basis. We submit that comparison of the cases of osteoid-osteoma cited here with those of bone abscess is by itself convincing as to this point. We need not repeat the evidence against the idea that osteoid-osteoma may have an infectious-inflam-

matory basis, since it is fully given in our 1940 article written in collaboration with Lichtenstein (2). In that article, as well as in the article of 1935 (1), we also explain why we do not think that the osteoid-osteoma lesion represents a peculiar healing or reparative form of some familiar lesion or that it originates from an embryonic rest. Altogether, we have been led both by the process of elimination and by consideration of the anatomic characteristics of the lesion itself to the conclusion that it should be interpreted as a neoplasm, and specifically as a peculiar benign tumor of bone.

We are aware that there are certain features of the osteoid-osteoma which may be held to be inconsistent with such an interpretation. First among these are the small size of the lesion (usually not exceeding 1 cm. in greatest diameter) and its seemingly self-limited nature, irrespective of its duration. Then there is the fact that it tends to incite the formation of a perifocal zone of bone sclerosis or thickening, sometimes of considerable magnitude, especially when the lesion is developing in relation to the shaft cortex of a long bone. The fact, however, that anatomically, and especially microscopically, the osteoid-osteoma nidus, when well evolved, does have the characteristics of a neoformation seems to us to outweigh in importance these apparently inconsistent or contraverting features. The latter are frankly puzzling and require explanation, but they only emphasize the peculiarity of the condition as a whole.

We have also been puzzled by certain features of the pathology of the lesion itself, and especially by the problem of interpreting the evolutionary sequence of the pathologic patterns seen in the various specimens. This problem can be only touched upon here. The genesis of the lesion is, in general, much more difficult to trace as it appears in the spongiosa than as it appears in the cortex, since it apparently evolves more slowly in the latter. At the site in the cortex where the lesion is developing, an intense reconstruction and vascularization of the original cortical bone sets in, spreading from the vessel canals. The original cortical bone at the site is soon substantially broken up and resorbed, but is replaced by highly atypical osseous tissue deposited by the osteogenic connective tissue carried on the walls of the blood vessels which are invading the area. While this focus of cortex is undergoing creeping replacement, the overlying periosteum may be depositing a thick layer of new bone of rather normal architecture. A clearly delimited nidus of closely compacted trabeculae of highly atypical new bone with few residua of the original bone soon comes into evidence. Progressively, one notes an increase of vascularized osteogenic connective tissue between the compacted trabeculae of atypical bone, and these trabeculae are, in turn, replaced. What we come to see now at the affected site is what we interpret as the evolved lesion—that is, a highly vascularized substratum of osteogenic connective tissue undergoing osteoid and osseous metaplasia. When the writer coined the name of osteoid-osteoma, it was this advanced stage that he was designating and whose unique appearance he was trying to summarize.

TREATMENT

It is clear from what has already been said that surgical removal of the lesion is all that is needed to bring prompt and lasting relief from the complaints. The nidus and some of the neighboring bone may be removed by curettement, but this should be thorough, since otherwise there is danger of recurrence of the complaints. The only disadvantage of curettement is a purely scientific one—namely that the tissue may be so crumbled that, unless the pathologist or surgeon is thoroughly familiar with the condition, he may fail to pick out the significant fragments (representing the nidus) for histologic examination and thus fail to obtain confirmation of the clinical diagnosis. The writer, in acquiring his experience with the lesion, has sought, wherever possible, to obtain the nidus in-

tact in its setting so that he would be completely oriented in studying its pathologic anatomy. Indeed, resection of the lesion intact in its setting, if possible, remains the procedure best calculated to facilitate wider understanding of the condition while abolishing the complaints of the patient.

What the ultimate status would be in any of our cases had there been no surgical intervention at all, we do not know. It is noteworthy, however, that among our patients there were a few with complaints for as long as three or four years, and one in which they had been present for five years before the lesion was removed and relief ensued. Nevertheless, it is conceivable that an osteoid-osteoma might, after many years, undergo spontaneous clinical arrest or even anatomic involution. However, in view of the severity of the clinical complaints and the ready accessibility of the lesion, in most cases, for surgical removal, it will not easily be possible to collect information on this point. Nor do we know what irradiation therapy can do for an osteoid-osteoma in either an accessible or an inaccessible site.

SUMMARY

The lesion designated as osteoid-osteoma of bone is discussed on the basis of a total experience now covering 62 cases. The condition has a predilection for males over females in the proportion of about 2 to 1; it is found predominantly in older children, adolescents, and young adults; and, though it may affect almost any bone, shows a strong preference for the lower limb bones and especially the femur and tibia. On the basis of the wider experience, it is reaffirmed that the lesion is a highly distinctive one and an entity *sui generis* in the pathology of bone disease, and that it is to be interpreted as a benign tumor of bone, albeit a peculiar one. When well advanced in its evolution, the lesion consists, in varying proportions, of osteoid, trabeculae of newly formed osseous tissue, and a substratum of highly vascularized osteogenic connective tissue.

The lesion usually does not exceed a centimeter in its greatest dimension, and, in a given affected bone, may lie within the spongiosa (perhaps at or near an articular surface), or against the inner surface of the bone cortex, or even actually within the cortex. An osteoid-osteoma stands out from the surrounding osseous tissue as a sharply delimited nidus, but the total abnormal area in the affected bone may be very large, since there may be a perifocal zone of bone thickening or sclerosis extending for a considerable distance beyond the nidus.

In interpreting the roentgenographic picture in a case of osteoid-osteoma, one must remember that this picture has two aspects—the manifestation of the nidus or osteoid-osteoma proper and that of the reaction which it has incited in the surrounding tissue. When this picture is characteristic, the affected bone shows the nidus as a small, oval or roundish, relatively radiolucent or (less frequently) radiopaque area, often surrounded by a more or less opaque or dense shadow reflecting the reactively thickened or otherwise altered zone of neighboring bone. While persistent local pain and a sharply localized point of tenderness are useful indications in the diagnosis, it is the roentgenographic picture that constitutes the most valuable single diagnostic guide. Removal of the lesion is followed by prompt and lasting disappearance of the complaints.

In an attempt to convey a well rounded picture of the condition as one encounters it in individual instances, 5 recent cases are discussed in detail and illustrated. The presentation also includes a discussion of the differential diagnosis, especially from bone abscess.

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The Use of Radioactive Sodium as a Tracer in the Study of Peripheral Vascular Disease[1]

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THE EMPLOYMENT of various artificially radioactive elements as "tracers" has been reported in a considerable number of biological and physiological studies. Atoms of a radioactive isotope of any element are chemically indistinguishable and inseparable from atoms of its normal stable isotopes. If they are administered to a living organism, the result is the same as from administration of the stable isotope, unless such a large amount is given that the accompanying radiation produces an effect. Each radioactive atom, however, in disintegrating emits beta or gamma radiation (or both) which can be detected in various ways.

Any desired substance can thus be "tagged" by mixing with the stable atoms a relatively very small number of radioactive ones. The tagged atoms continue to be mingled with the normal ones administered at the same time, in the same proportions throughout their whole course through the body, except for radioactive decay, which can be allowed for if necessary. Hence, by determining the activity of a sample of tissue or excreta at any time after the administration of a labeled dose, the percentage of the recently administered material can be determined. Some substances emit such penetrating radiations that their presence in various parts of the living organism can be detected and measured.

Such an isotope is radioactive sodium, Na^{24}. Following its introduction into the body in any manner, its transfer by the blood and its arrival at any part can be observed by the use of a Geiger-Müller counter. In the studies to be reported in the present paper, a few cubic centimeters of normal saline containing the desired amount of the radioactive isotope were injected intravenously, and the circulation of the blood was traced by following the sodium it carried.

Studies of this type have now been carried out on more than 200 patients with peripheral vascular disease. The method provides a simple and objective means of determining the blood supply to an extremity through either the main arteries or collateral circulation. Since the viability of an extremity depends upon its blood supply, it is evident that any information on this subject should be useful in diagnosis, prognosis, and evaluation of therapy. In practice the observations obtained by this method have been especially helpful in demonstrating the competency of the collateral circulation when the main arteries are partially or totally occluded. This is valuable in determining the probable reparative powers of the tissues locally, the justification for continued local conservative surgery, the presence of sufficient arterial blood supply in a given region to warrant reasonable expectation of primary or secondary wound healing of an amputation site, and the degree of operative trauma which such a site might successfully tolerate. Repeated tests at intervals during a course of therapy (local or systemic), or following its completion, furnish a means of evaluating the treatment and thus of estimating prognosis. The method is simple, accurate, objective, and does not require hospitalization. The incidental dose of radiation delivered to the patient by the complete disintegration

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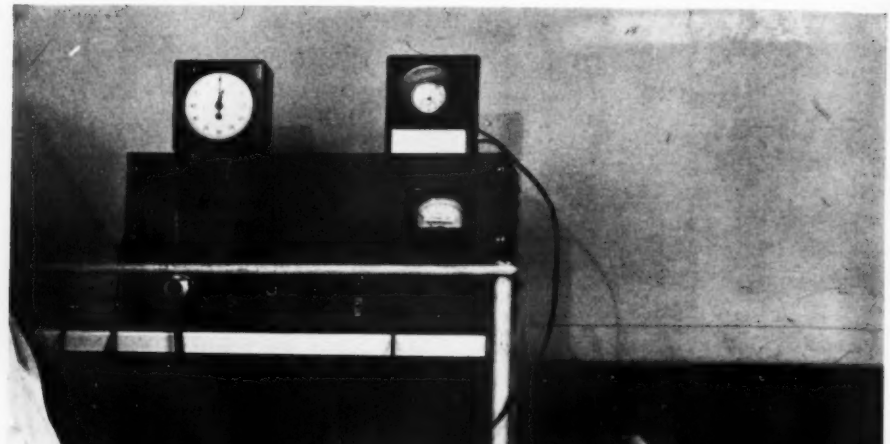

Fig. 1. Geiger-Müller counting tube, amplifier, and scaling circuit. The shielded tube is shown in position against the foot of a patient.

within his body of the administered radiosodium is considerably less than one roentgen.

The radioactive sodium is prepared in the cyclotron by bombarding sodium metaborate with deuterons. The metaborate containing the active atoms is dissolved in water, acidified with hydrochloric acid, and treated with methyl alcohol, resulting in the formation of methyl borate, sodium chloride, and water. The solution is evaporated to dryness and heated to remove excess acid; the material is then dissolved in pyrogen-free distilled water, to give the desired concentration for injection, and autoclaved for an hour.

The counting apparatus is shown in Figure 1. The Geiger-Müller counting tube is shielded in half an inch of lead except for a thin aluminum window 7×5.5 cm., which is placed against the region to be studied, as the patient lies comfortably in bed. Usually the study is started with the window of the counter against the distal plantar metatarsal region of a foot; the material is injected into an antecubital fossa vein, and thus arm-to-foot circulation time can be immediately established. Certain precautions are essential. The predetermined dose of the isotope—usually about 100 microcuries in 5–12 c.c. of solution—is drawn into an accurately graduated syringe, with care not to contaminate the outside of the syringe, the hands of the injector, or the environment of the patient. The needle must be secure on the syringe. With the syringe containing the material held close to the site of injection, the scaling device on the counter is adjusted so that one or two clicks are heard every five seconds. These are due to cosmic and other background radiation as well as to the radioactive isotope to be injected. When this background has been established, venipuncture is carefully done after the application of a tourniquet. A

19 to 22 gauge needle is used, depending on the size of the recipient's vein; care is taken to be sure that the bevel of the needle lies entirely within the vein. The injection and the electric stop clock are started simultaneously, and counts are recorded every five seconds, the time of the end of the injection being also noted.

The arrival of the radioactive substance in the tissues in contact with the counter is signaled by a definite increase in the counting rate. In normal subjects and in many with vascular disease, the increase is marked and abrupt, but in some patients with considerably lowered circulation it is so gradual that it is difficult to say just when the material first arrived. It is for this reason that five-second counts are recorded, instead of reliance being placed solely upon auditory recognition of increased counting rate. The interval from start of injection to time of arrival is arm-to-foot circulation time.

If the counter is left in position against the foot, and counting is carried on minute by minute, it is found that the count increases steadily and markedly for some time. This should be expected as the result of interchange of the injected radiosodium between plasma and extravascular fluid until equilibrium is established between the two. The manner in which this equilibrium is built up depends on the rate of delivery of the isotope to the part by the existing main and collateral circulations and on the relation between the local intravascular and extravascular space; these depend on the normal or diseased condition of the extremity. The shape of the "build-up curve" gives valuable clinical information relative to the condition of the arterial vessels maintaining the viability of the part.

Counts may also be taken at other positions, such as calf, popliteal region, thigh. Comparison of counts at the same level in the two legs is useful in determining relative extent of the disease process.

The following types of case have been studied: (*a*) normal, *i.e.*, young and middle-aged persons who have normally palpable vessels and no history of vascular disease; (*b*) arteriosclerosis; (*c*) diabetes with arteriosclerosis; (*d*) thrombo-angiitis obliterans; (*e*) extremities subjected to freezing during a blizzard; (*f*) immersion foot in patients exposed in the ocean or in open boats following torpedoing of ships; (*g*) scleroderma; (*h*) essential hypertension; (*i*) varicose veins with edema and ulcerations; (*j*) arteriovenous fistula; (*k*) glomic tumor; (*l*) Raynaud's disease; (*m*) arteriosclerosis with peripheral multiple femoral aneurysms; (*n*) aneurysm of abdominal aorta; (*o*) hemangioma of lower extremity; (*p*) congenital hypertrophy of an extremity; (*q*) erythromelalgia; (*r*) hypertrophic osteoarthropathy; (*s*) deformed ulcerated edematous extremity in which no arteries could be palpated because of deformity and edema; (*t*) lymphedema. In some of these conditions only a single patient has been observed to date; in others, however, series of 10 to 15 cases have been studied.

TABLE I: CIRCULATION TIMES, ARM-TO-FOOT

Diagnosis	Number of Cases	Average Time, Seconds	Range, Seconds
Arteriosclerosis	24	45	20–105
Arteriosclerosis with diabetes	13	42	25– 90
Arteriosclerosis with diabetes and infection	5	27	20– 40
Thrombo-angiitis obliterans	12	33	20– 70
Scleroderma	5	44	15– 75
Chronic varicose ulcer	3	38	30– 45
Hypertension	13	41	20– 80
Post-frozen feet	6	43	25– 60
Miscellaneous	39	34	15– 75
Normal (no evident vascular disorder)	11	43	20– 55
All Cases	131	39	15–105

In Table I are presented the data on circulation time in 131 cases; the average value is 39 seconds, but the range is considerable. The highest, 105 seconds, was in an elderly arteriosclerotic; the lowest, 15 seconds, in a young man with a pulse of 100, suffering from scleroderma. In the arteriosclerotic groups and in hypertension there is considerable variation; in general, it can be said that slower times are associated with more advanced stages of dis-

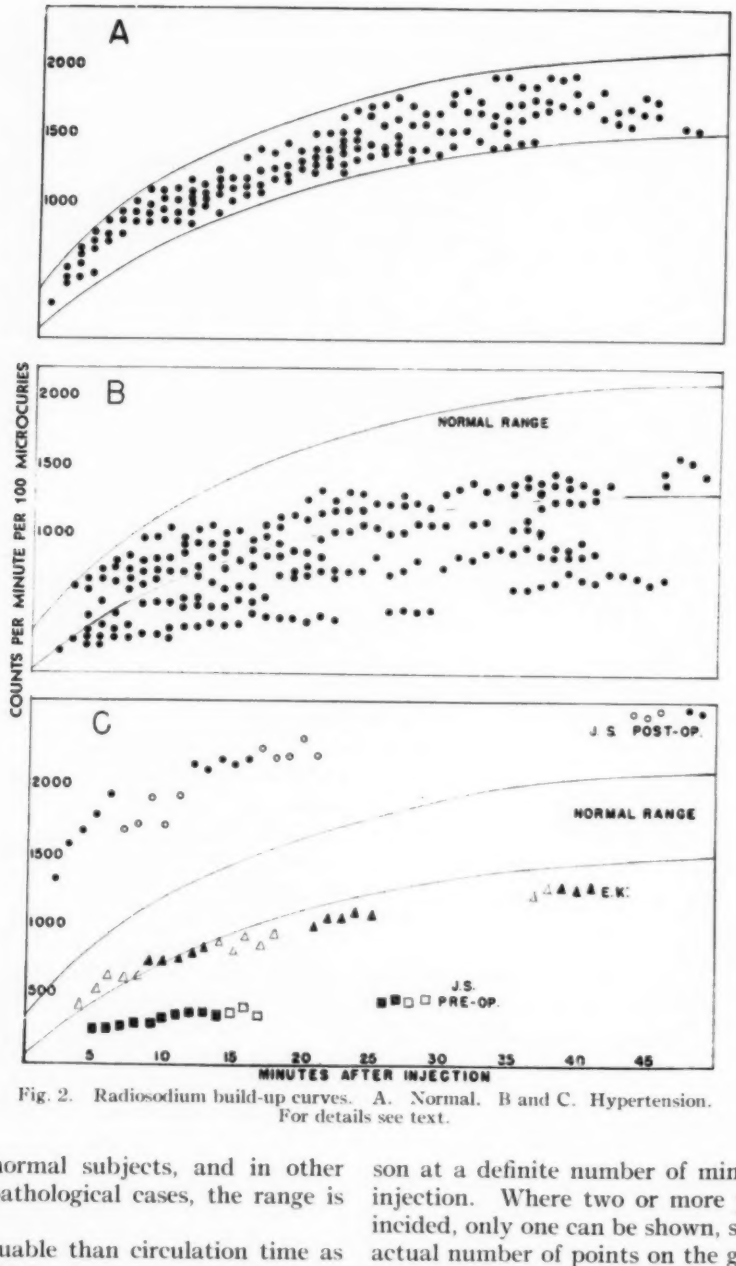

Fig. 2. Radiosodium build-up curves. A. Normal. B and C. Hypertension. For details see text.

ease. In normal subjects, and in other groups of pathological cases, the range is less.

More valuable than circulation time as a clinical aid is the curve of equilibrium build-up discussed earlier. Figure 2, A, shows data for 11 persons with no known vascular disease. Points represent counts per minute, per 100 microcuries injected; each point represents a count on one person at a definite number of minutes after injection. Where two or more points coincided, only one can be shown, so that the actual number of points on the graph does not indicate the total number of observations. The subjects varied in weight from 116 to 193 pounds, in height from 5 to 6 feet, and in age from 14 to 45 years. No allowance or correction is made for any of these factors, in either the normals or the

diseased subjects. While there is considerable variation among individuals, it is evident that there is in all cases a rapid increase during the first few minutes, with a slower increase thereafter to the end of the chart. In no instance was there any difference between counts in the right and left foot of a normal subject.

In Figure 2, B, are shown counts for 10 patients with essential hypertension. The range here is much greater than for the corresponding group of normals just above. On the whole, these patients exhibit a build-up curve lower than normal, only 2 of the series remaining within the normal range at the end of half an hour.

Two cases from the group of Figure 2, B, are repeated in Figure 2, C, to illustrate different aspects of the disease. In this and all subsequent charts, closed or solid symbols represent counts at the right foot; open symbols, counts at the left foot. Patient J. S. is a young woman without clinical or x-ray evidence of arteriosclerosis. Her low preoperative curve is thought to have resulted from peripheral vascular spasm. Following bilateral thoracolumbar sympathectomy, the curve has ascended well above the normal range. The patient has been, for the year following operation, completely relieved of her symptoms. No recent measurement of blood pressure is available as she is out of the country. Patient E. K., a middle-aged man, had evidence of peripheral sclerosis and nephritis in addition to his essential hypertension. His curve is nearly normal, indicating little or no spasm. He succumbed with cerebral hemorrhage four months after sympathectomy and before a postoperative sodium study could be made.

Figure 3 presents data for patients with systemic and peripheral arteriosclerosis. Figure 3, A, gives curves for 5 cases uncomplicated by other systemic diseases; they are uniformly below normal except for the right foot of one person. This patient is the only one of the group who has come to operation; he underwent bilateral amputation below the knee by modified guillotine technic for uncontrolled pain in the feet. Pathological examination of the nerves did not show ischemic neuritis, and it is a clinical presumption that his pain was the result of local anoxia, in spite of the high sodium reading (indicating reasonably good circulation). The wounds healed by primary union; rehabilitation with an artificial leg occurred two or three months after each operation.

Figure 3, B, shows data for two arteriosclerotics with severe diabetes, each having extensive infection in the right foot. The high counts for these right feet are attributed to the increased blood supply due to inflammation. The clinical condition in each of these patients was such that amputation seemed indicated. They were, however, treated by conservative surgery, with digital amputation only. Both are walking, with all toes off the right foot, some months after treatment. The high count, indicating abundant blood supply, is considered prognostic of good wound healing, even in the face of infection.

In Figure 3, C, are data for three patients with arteriosclerosis complicated by diabetes and with clinical evidence of diminished blood supply. All show low counts except the right foot of patient R. V., which is normal. She had gangrene of two toes on the left foot and underwent a modified guillotine amputation of the left leg below the knee. The wound opened and required subsequent grafting; four months after the amputation she was fitted with an artificial leg. Patient J. K., with a similar curve, showed healing following an amputation below the left knee. Patient I. M., in spite of low counts indicating restricted circulation, showed healing of an area of gangrene on the right great toe and of the second toe amputation site on the left foot. These patients are all well a year or more after treatment.

In Figure 4, A and B, are presented data for a group of patients with thrombo-angiitis obliterans. These are, in general, not far from the normal range. The three cases of Fig. 4, A, have done well following conservative surgery. Sodium tests in all these cases were two years or more post-

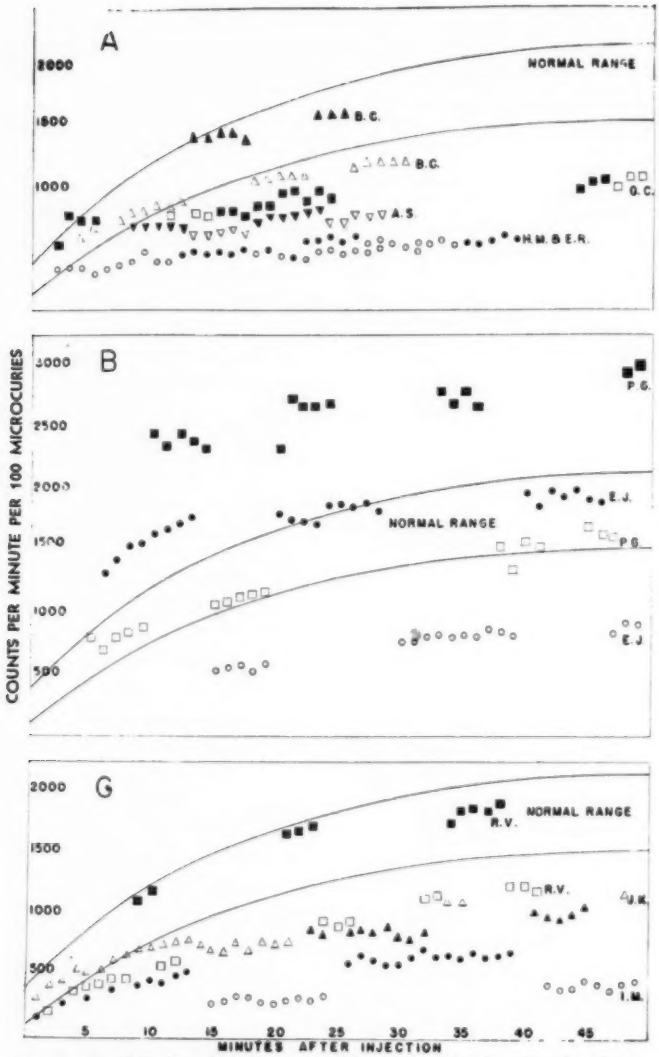

Fig. 3. Radiosodium build-up curves in arteriosclerosis. For details see text.

operative; in the two amputated cases (J. C. and R. S.) they indicate good blood supply at present. It is probable that such blood supply existed at the time of operation, accounting, at least partially, for satisfactory healing. Patient J. I. has remained without symptoms for eight years after a peripheral nerve block due to crushing of the posterior tibial, anterior tibial, superficial peroneal, and sural nerves. Patient J. C. has worn an artificial leg without discomfort for seven years, following a modified guillotine amputation below the right knee. Patient R. S. is a female with healing of a right great toe amputation site, who has since been ambulatory for three years without symptoms. The pathological examination of the arteries in the amputated specimen confirmed the diagnosis of thrombo-angiitis obliterans.

Figure 4, B, gives data for patients with active thrombo-angiitis obliterans. In this

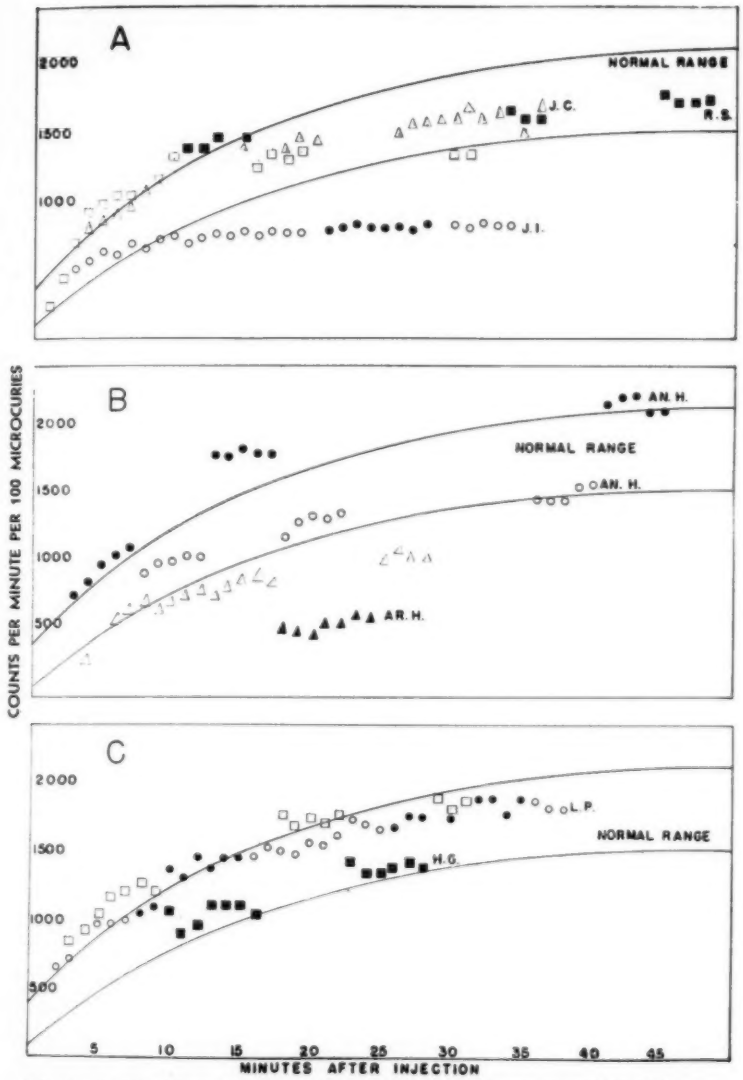

Fig. 4. Radiosodium build-up curves. A and B. Thrombo-angiitis obliterans. C. Chronic varicose ulceration. For details see text.

type of patient, if one foot is more definitely involved in the pathological process than the other, the two usually present different counts; this is well illustrated by the two cases shown. Patient Ar. H. came to amputation below the right knee; the arteries of this extremity showed changes typical of thrombo-angiitis obliterans. Subsequently, in another hospital, he underwent amputation below the left knee. The single slide made available to the Presbyterian Surgical Pathology Laboratory from that hospital showed *changes typical of arteriosclerosis, but no evidence of thrombo-angiitis obliterans.* This is of interest in view of the low sodium curve for the right and approximately normal one for the left foot. Patient An. H. has suffered repeated ulcerations of the right great toe, which shows slight healing with no gangrene.

The high count is associated with local inflammatory changes.

Two cases of chronic varicose ulceration are illustrated in Figure 4, C. Patient L. P. exhibits the condition in both medial lower third crural regions; patient H. G. has an intractable ulceration on the left great and second toe, associated with varices on the dorsum of the foot and in the internal saphenous vein. The dorsalis pedis and posterior tibial arteries in both cases are normally palpable, and their sodium counts lie within the normal range.

Various types of vascular obstruction are demonstrated in Figure 5. In A are data for two patients with thrombosis of the abdominal aorta, both proved by postmortem examination. Sodium tests were done soon after the onset of symptoms, and a few days before death. In patient E. H. very low counts were obtained at both feet. She showed gangrene of both lower extremities. A right lower third of the thigh amputation was done; the site became gangrenous. This patient also had multiple sacral, buttock, and abdominal wall decubiti. Patient C. S. showed no count whatever at his right foot but, on the fifth day following his accident, a fairly adequate count at the left. Amputation sites at the upper third of the right thigh and lower third of the left thigh granulated. The patient had a paralyzed bladder and rectum and an enormous sacral decubitus.

Figure 5, B, demonstrates 3 cases of advanced peripheral arteriosclerosis in young people in whom femoral arteries were not palpable. In patients J. D. and E. W., neither femoral was palpable and both feet showed low counts; patient Y. S. had a palpable right femoral artery and a normal right foot curve. Her left leg has responded very slowly to pressure-suction boot, whirlpool bath, and massage treatments. Patient E. W., with marked cyanosis of both feet, is responding slowly but definitely to the same type of physical therapy. Patient J. D., after five years of clinical observation, succumbed to a coronary thrombosis, one year after a right hemiplegia from a cerebral thrombosis.

Four cases with venous involvement are illustrated in Figure 5, C. Patient M. N. represents an extraordinary case of thrombophlebitic gangrene of both feet, of unknown etiology but associated, as proved postmortem, with a carcinoma arising from the bile radicles of the left lobe of the liver. The extremities were very edematous, which probably accounts for the nearly normal sodium reading after half an hour, since after this interval sodium is contained in any extracellular fluid. Patient A. H. had, clinically, a phlebitis emanating from the right deep calf veins, with venographic evidence of occlusion of the right femoral vein. The right foot was edematous. The curve for the uninvolved left foot is a low normal; the higher values for the right are due to the presence of edema fluid, since this also takes up sodium. Patient F. S. had an extreme femoral-iliac phlebitis with varicose ulcerations of both lower leg regions, associated with scleroderma. The low counts could be due to the latter condition (see Fig. 7, A) but may also indicate diminished circulation from other causes. Patient J. S. had thrombophlebitic gangrene resulting from prolonged ice therapy of the left foot and lower third of the leg because of pain. The indicated count is entirely due to sodium in the rest of the body; none of the material reached the foot. Following amputation just above the gangrenous region, the arteries in the foot were seen to be patent, the veins thrombosed. The operative site healed readily.

In Figure 6, A and B, are shown cases of immersion foot and frostbite. Patients J. M. and J. W. had immersion foot following exposure to water and cold in open boats in the North Atlantic a year prior to the tests. J. W. showed no obvious pathological changes. The dorsalis pedis and posterior tibial arteries were normally palpable, but he complained of severe pain, especially on walking and on exposure to cold. His low count was rather surprising and is not readily explained. J. M. had similar findings but his pain was less severe, as might be deduced from his higher curve. I. K.'s left foot was frozen in a bliz-

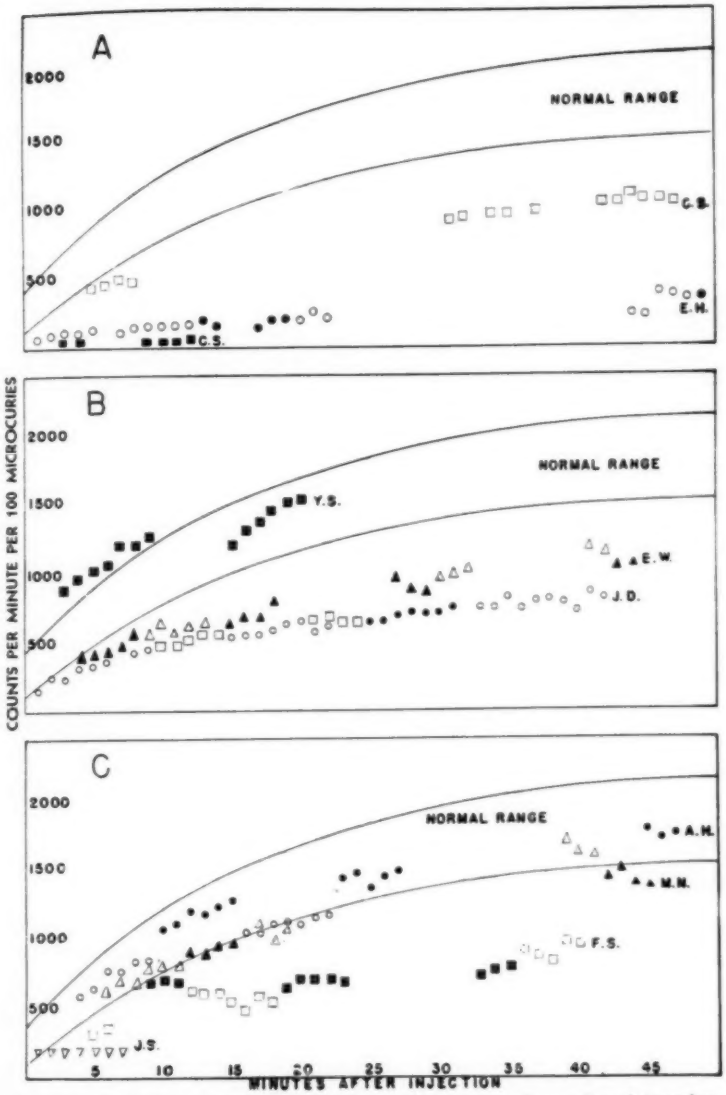

Fig. 5. Radiosodium build-up curves in various types of vascular obstruction. For details see text.

zard nine years ago. Part of the first and second toes sloughed off; the foot has remained healed. The fact that both feet show rather low curves suggests slight bilateral involvement. Patient N. S. (Fig. 6, B) had immersion foot following exposure in the South Indian Ocean in winter. He has undergone a left lumbar alcohol block, for pain. The resultant release of vasoconstriction is demonstrated by the very high sodium count on that side. The untreated right side still shows the low count associated with immersion foot. In view of the increase in count following lumbar block in this instance, and for other reasons, posterior tibial nerve blocks with perineural novocaine infiltration at the internal malleolus were done in some other cases. Figure 6, C, shows the result in two cases of peripheral arteriosclerosis. The nerve

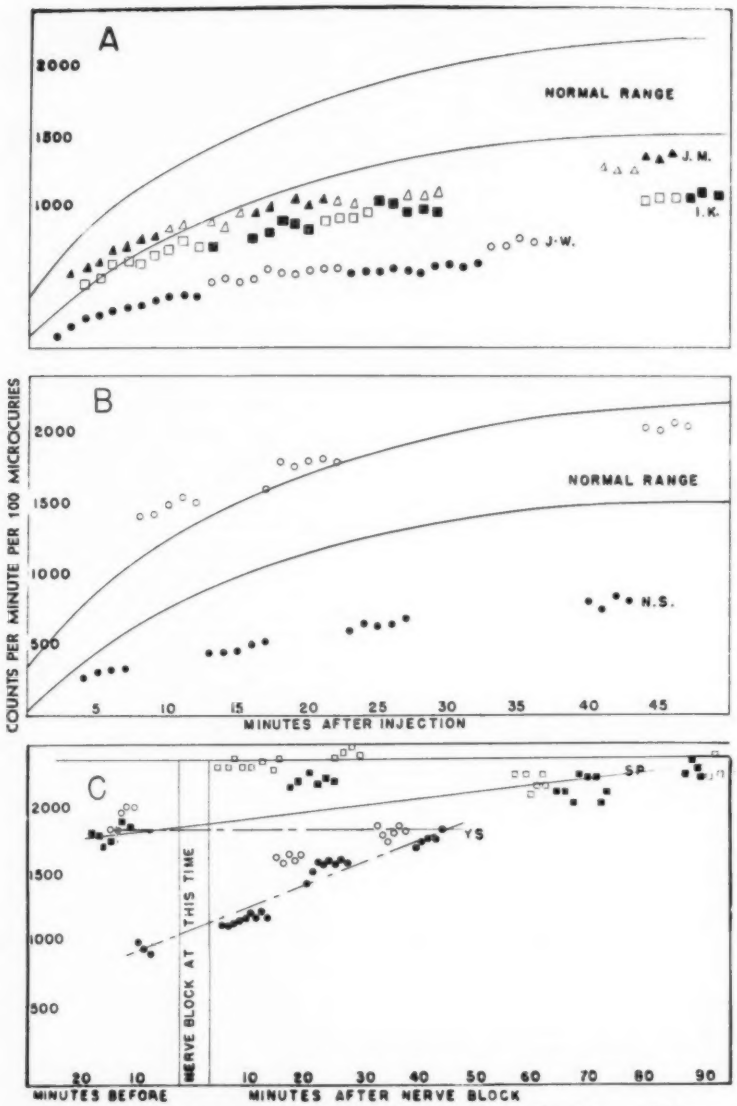

Fig. 6. A and B. Radiosodium build-up curves in frostbite and immersion foot. C. Increase in sodium count after tibial nerve block. For details see text.

blocks were done more than an hour after the sodium injection and when the curves had become stable. Patient S. P. had come to a low normal level, that for the left, more painful, foot being somewhat higher. Y. S. exhibited the same relatively high count in the painful foot; that for the supposedly uninvolved one was quite ow. By the end of an hour after injection, sodium equilibrium between intravascular and extravascular fluid is almost reached. For this reason release of arterial spasm could not be expected to produce much increase in count, but might be demonstrable. In both of these cases, the count increased in the non-painful foot, markedly in Y. S., slightly but definitely in S. P., demonstrating that some vascular dilata-

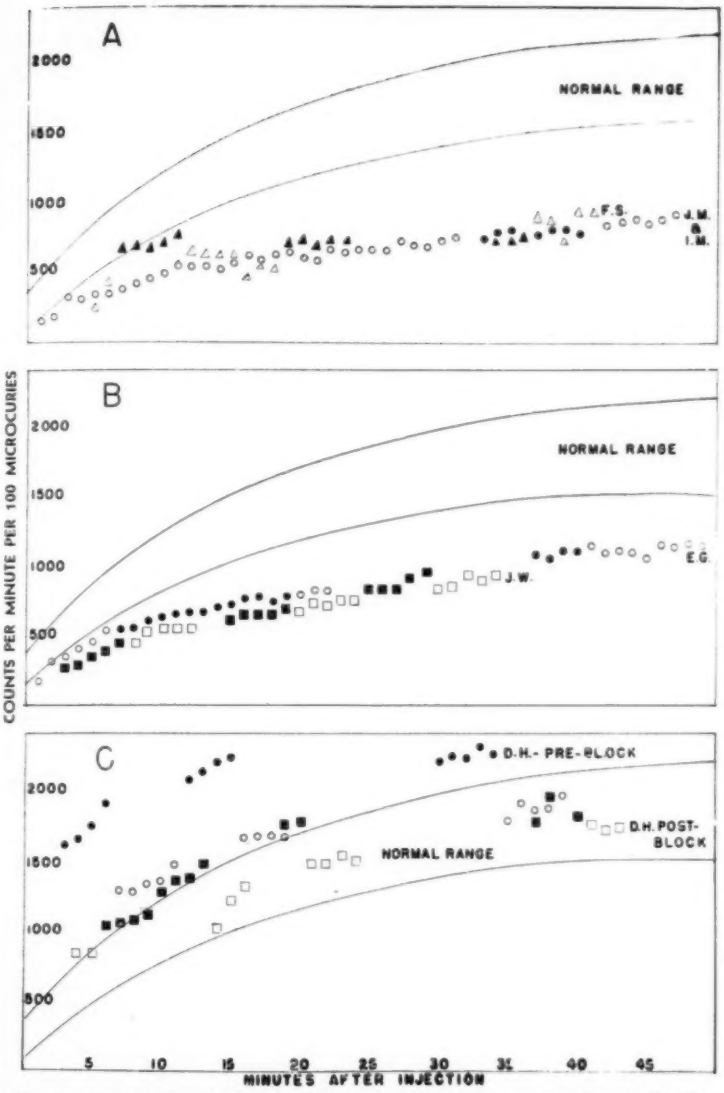

Fig. 7. Radiosodium build-up curves. A. Scleroderma. B. Raynaud's disease. C. Erythromelalgia. For details see text.

tion did occur. No change was found in the very painful foot; this is a significant clinical finding.

Figure 7, A, shows data for three characteristic cases of scleroderma. These patients always exhibit low curves. In Figure 7, B, are curves for two cases of Raynaud's disease; these are also low. In patient E. G. this low curve was diagnostic. She complained of pain in her hands; her feet were symptomless, and it was thought that they would give counts within the normal range.

In Figure 7, C, is presented an interesting case of erythromelalgia following a slight trauma. In the acute stage of the disease, the count in the affected foot was very high, indicating inflammation or vascular dilatation. Following an alcohol lumbar sympathetic nerve block, the pain

was relieved and the count came to normal.

In addition to studies of the types just discussed at some length, some other investigations may be mentioned. Counts have been done on many persons at various levels of the legs; these are more variable than those at the feet because of the volume of tissue exposed to the counter. However, a basis has been established for recognizing satisfactory blood supply; this has made it possible, in a considerable number of instances, to amputate below the knee, with confidence that healing would occur. Previously many of these patients would have been subjected to amputation above the knee.

In a patient with an arteriovenous fistula in the thigh, diminished blood supply to the foot on that side was demonstrated, with return to normal supply following repair of the fistula.

In a selected group of cases, repeated counts are being made following the use of various drugs or types of physical therapy; these findings will be published later.

SUMMARY

An objective method is presented for the study of blood circulation; this is of particular interest in its applicability to patients having peripheral vascular disease. Its use in more than 200 cases to date has given valuable clinical aid by determining circulation time and demonstrating competency of the arterial circulation. It has been of special value in determining the advisability of persisting in conservative as compared to more radical local surgery, and particularly in determining the site of amputation at which healing might be expected. In this capacity it has justified the clinical attitude that in many cases of amputation for gangrene in peripheral vascular disease the knee joint can be saved.

Since no toxic material is injected with the sodium, and the accompanying dose of radiation is considerably less than one roentgen for each test, there is no contraindication to its repetition at reasonable intervals. In this manner it serves to follow progress of the disease or to test the efficacy of therapeutic measures.

More cases are continually being studied by this method with the aim both of obtaining information about the individual patient and of building up series of similar cases from which it may be possible to draw general conclusions.

NOTE: The authors wish to express their indebtedness to Professor Dunning, Dr. Reid, Dr. Glassford, and other members of the staff of the cyclotron laboratory of Columbia University, who lent the apparatus and are providing the sodium for the work. Without their co-operation this study could not have been carried on at this time. They also wish to thank Mrs. Ruth Petro for her technical assistance in carrying out the counts on patients, preparing charts, and keeping records.

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The Roentgen Appearance of Lobar and Segmental Collapse of the Lung

VI. Collapse of the Upper Lobes[1]

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COLLAPSE OF A single lobe of the lung is most frequently misinterpreted when it occurs in one of the upper lobes. It is confused with a localized area of consolidation, a mediastinal tumor, or an aortic aneurysm, and in some instances, especially in the presence of a long standing fibrotic process without apparent atelectasis, it may be completely overlooked. Its occurrence is relatively infrequent as compared with collapse in the lower lobes or the middle lobe, but it is common enough to warrant greater emphasis than has been given it in the literature. In the group of 600 cases forming the basis of this study,[2] the upper lobes were involved in 95, or 16 per cent. Certain roentgenologic signs which characterize collapse of an upper lobe and which, if recognized, will lessen some of the confusion regarding its diagnosis will be described.

It has been noted in earlier papers of this series that in the majority of instances it is possible with satisfactory technic to demonstrate the septa which bound the individual lobes of the lung. These lines, which roentgenologically can be thought of as partitions between the various lobes, are seen to best advantage on the lateral roentgenogram. The routine postero-anterior view is depended upon to show any abnormal shadow of increased density, the presence and degree of emphysema in the adjoining lobes, the position of the trachea and upper mediastinum, the relative planes in which the hili are located, and usually the minor septum.

The upper lobes lie superiorly and anteriorly in the chest; that is, the left upper lobe is anterior to the major septum along its entire course, while the right upper lobe lies above the minor septum and anterior to that portion of the major septum above its junction with the minor septum. The location of a normal lobe in relation to the septa is stressed repeatedly because of its diagnostic significance. By the recognition of the individual lobes and the septa which bound them, it becomes more nearly possible to demonstrate on a roentgenogram the precise unit of a lung that is projected on a given area. In this way, it is possible roentgenologically to recognize the presence of a pulmonary unit which is not assuming its full share in aeration even before an abnormal shadow of increased density, indicating the nature of the disease process (or in some instances its result) can be detected. The significance of this concept is similar to that of a break in the peristaltic wave in the stomach pointing to a neoplasm or ulcer crater which otherwise might be overlooked.

With a few exceptions, the roentgen appearance of collapse of an upper lobe or of its segments is essentially the same regardless of the side involved. On the left, the lingula of the upper lobe occupies a position in the chest similar to that of the middle lobe on the right, but it derives its bronchial supply from the left upper lobe bronchus and is not separated from the remainder of the upper lobe by a fissure. The similarity in the appearance of a right middle lobe and a lingula on the left has been previously mentioned. The lingula is often collapsed when the remainder of the left upper lobe is involved, but in

[1] From the Department of Radiology, Massachusetts General Hospital, Boston 14, Mass. One of a series of papers accepted for publication in October, 1944.
[2] See Radiology **44:** 471, 543, May and June 1945; **45:** 23, 120, 260, July, August, September 1945.

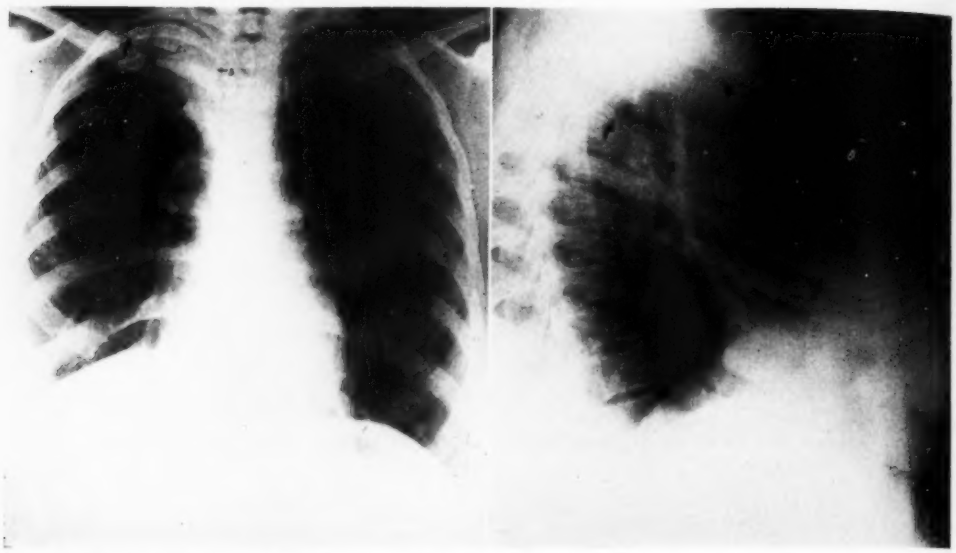

Fig. 1. Complete collapse of the right upper lobe. The shadow of increased density, outlined by arrows, represents the collapsed right upper lobe. The trachea is deviated slightly to the right; the right hilus is elevated. The aerated portion of the right lung field is filled by emphysematous right lower and middle lobes. In the lateral view, the arrows indicate the anteriorly displaced major septum of the right lung. The aerated portion of the lung anterior to the septum is middle lobe. The asterisk overlies the collapsed right upper lobe.
Right upper and middle lobectomy. The right upper lobe was markedly decreased in size.
Histopathology: Tuberculosis.

none of the cases studied was collapse of a middle lobe associated with a similar process in the right upper lobe, unless the entire lung was collapsed. In a discussion of the upper lobes, therefore, the presence of the lingula on the left is significant only when it and the remainder of the left upper lobe are simultaneously collapsed. When this occurs, the entire shadow of increased density is slightly larger than that of collapse of the right upper lobe and it extends farther inferiorly along the anterior chest wall.

Demonstration on the lateral roentgenogram that a major septum is no longer in its normal position may be the first evidence suggestive of decrease in the size of an upper lobe. The septum will appear to lie farther anteriorly, and its superior portion will extend higher in the chest. At about the time the lobe has diminished to approximately two-thirds of its normal size, it may be noted that the supposedly normal pulmonary markings appear to be somewhat more closely grouped than is usually seen. As the collapse increases, the lung markings seem to be actually crowded together, and the lobe is seen to occupy a constantly diminishing space. At this point the increased number of markings per unit area will usually make the now small lobe cast a definite shadow of increased density in contrast with the adjacent uninvolved lung. The latter will now be emphysematous, since it necessarily has had to increase in size to fill the space formerly occupied by the collapsed lobe which, as it became smaller, continued to move further anteriorly and medially.

Collapse of an upper lobe produces a shadow of increased density rather typical in shape and position in the chest. It is somewhat fan-shaped or triangular, with a fairly broad base as it first becomes visible. As the process progresses, however, the base, or peripheral border, becomes shorter, the appearance being comparable to the gradual closing of a once fully opened fan. The apex of the shadow appears to arise from the top of the hilus and its base

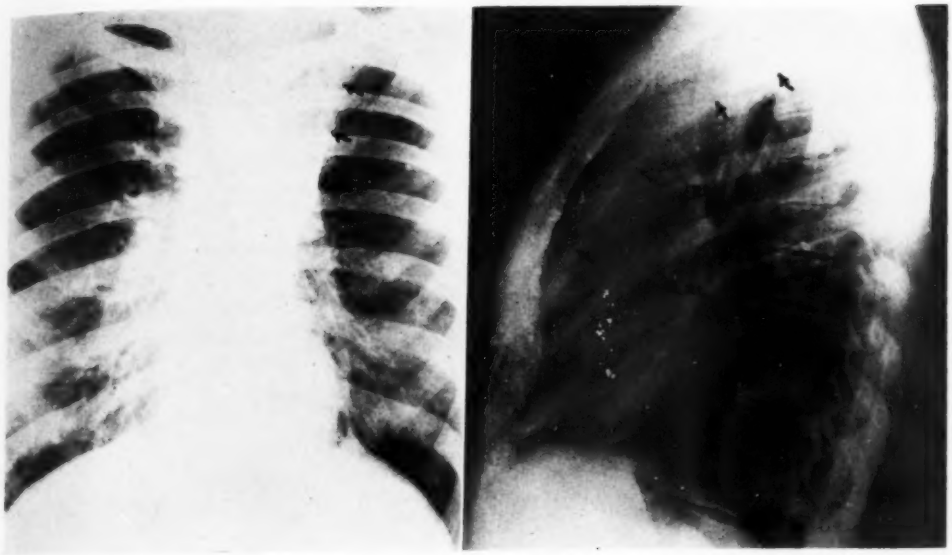

Fig. 2. Complete collapse of the left upper lobe. The lateral margin of the shadow of increased density is indicated by arrows. The left hilus is elevated. The aerated lung in the left chest is left lower lobe. In the lateral view, the posterior margin of the shadow of increased density is shown anteriorly in the left chest (arrows) and represents the posterior margin of the collapsed left upper lobe. The positions of the right major and minor septa are indicated. This is the typical appearance of collapse of an entire upper lobe.
Left upper lobectomy. The upper lobe was found to be completely collapsed.
Histopathology: Bronchiectasis.

extends against the top and anteromedial surface of the chest wall. Since the collapsed lobe lies in the gentle concavity of the medial and anterior portion of the pleural space, the shadow of increased density appears to be much the same shape in both postero-anterior and lateral roentgenograms. The position finally assumed by the shadow of density differs from that seen in collapse of a lower lobe, which always lies posteriorly rather than anteriorly if there has been no previous trauma to the pleura.

A collapsed upper lobe may in some cases become so small and move so far anteriorly and medially that in the postero-anterior projection the shadow of increased density will blend with that of the upper mediastinum and the combined shadow will merely suggest mediastinal widening.

In the lateral view, the shadow may become assimilated with that of the upper anterior chest wall and be readily overlooked. The area between the ascending and transverse portions of the aorta and the chest wall, which is normally of increased radiability, now becomes obliterated and approaches the density of the soft tissues. Nevertheless, the presence of a shadow of increased density can still be determined in this view if the surfaces of the ascending and transverse portions of the aorta are observed carefully to determine whether or not they are as distinctly outlined as usual. If the border of the aorta is partially or completely obscured, it can be assumed that it is adjacent to non-aerated lung; in other words, that the upper lobe is atelectatic. The appearance of the anterior surface of the ascending aorta is of importance particularly in relation to the right upper lobe, since the left contributes little to its visualization. In collapse of a left upper lobe, the transverse portion of the arch of the aorta may not be as clearly defined as usual, for like reason, since that portion of the aorta is more or less in contact with the lobe. It should be mentioned, also, that a collapsed entire left upper lobe seldom becomes as small

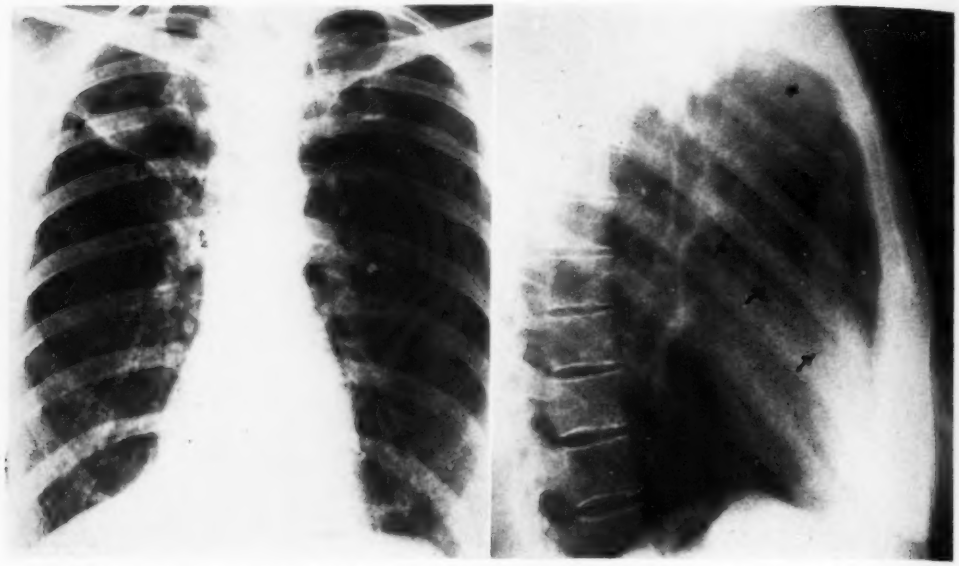

Fig. 3. Partial collapse of the right upper lobe. All of the segments appear to be nearly equally involved. The right upper lobe is considerably decreased in size, as demonstrated by the elevation of the right hilus and the upward displacement of the minor septum. The trachea is deviated to the right. In the lateral view, the asterisk indicates the position of the bulk of the collapsed right upper lobe. The right major septum lies somewhat farther anteriorly than usual.

Right upper lobectomy.

Histopathology: The right upper lobe was small, showing tuberculosis with cavitation and fibrosis as well as numerous tubercles.

as a collapsed right upper lobe because of the greater amount of lung tissue involved. In addition, the lingular portion will generally extend far enough down the anterior chest wall so that it can be recognized as an abnormal area of increased density, although in extreme collapse the lingular shadow may be difficult to identify, as it is very small and merges with the mediastinum.

As in collapse of a lower lobe, an upper lobe can be decreased in size without a great amount of atelectasis being visible. When this occurs, the roentgenogram is frequently interpreted as showing a minimal tuberculous lesion because the area of atelectasis is small and the decrease in the size of the lobe is not appreciated. Also, if the collapse is due to a chronic condition in which secondary fibrosis occurs, as in tuberculosis or bronchiectasis, the process may remain stationary for many years. If the cause of collapse of an upper lobe is an acute obstruction, the process will develop much more rapidly and will also clear more rapidly than with chronic obstruction.

As an upper lobe decreases in size, the hilus tends to move into a higher plane and its superior portion may be merged in the shadow of increased density. This blending of the two shadows often creates the impression that the hilus is elevated farther than is actually the case and probably explains why at times it appears to become smaller. In general, the elevation of the hilus depends upon the degree of collapse. As a rule, the elevation in collapse of an upper lobe was more striking than was the depression of the hilus associated with collapse of a lower lobe. If the collapse is of short duration, the change in the position of the hilus may be readily observed, for it will return to its normal position with re-expansion of the lobe. The presence of a tumor occasionally seems to interfere with the elevation of the hilus in collapse of an upper lobe.

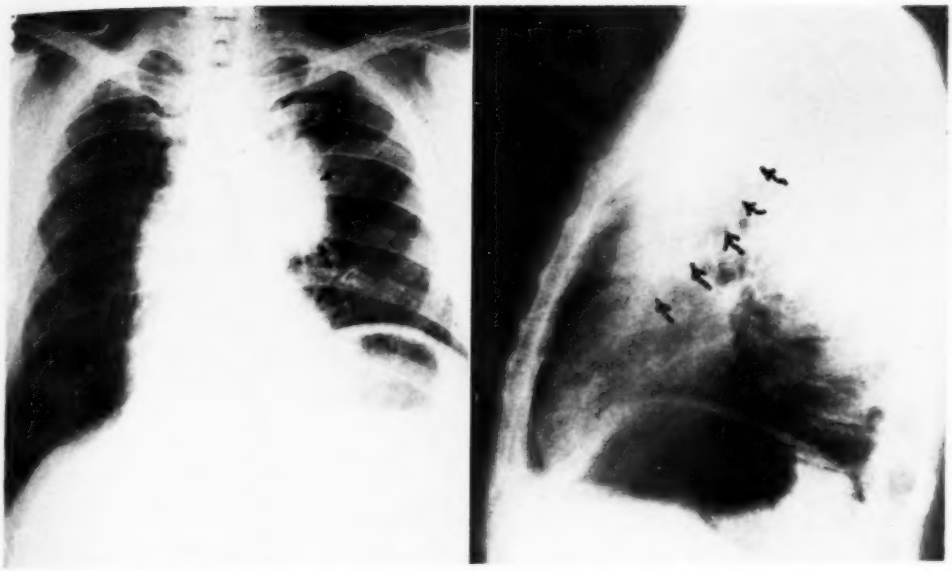

Fig. 4. Collapse of the left upper lobe excluding the lingula. The shadow of increased density is outlined by arrows. The diaphragm is elevated, and fluoroscopically showed paradoxical motion. The left heart border is clearly outlined. In the lateral view, the posterior margin of the shadow of density represents the major septum which has been displaced anteriorly and superiorly. The lingula is seen to be fairly well aerated.

Exploratory thoracotomy. The upper lobe was found to be extensively involved in a carcinomatous mass which was inoperable because of mediastinal extension.

Histopathology: Epidermoid carcinoma, grade III.

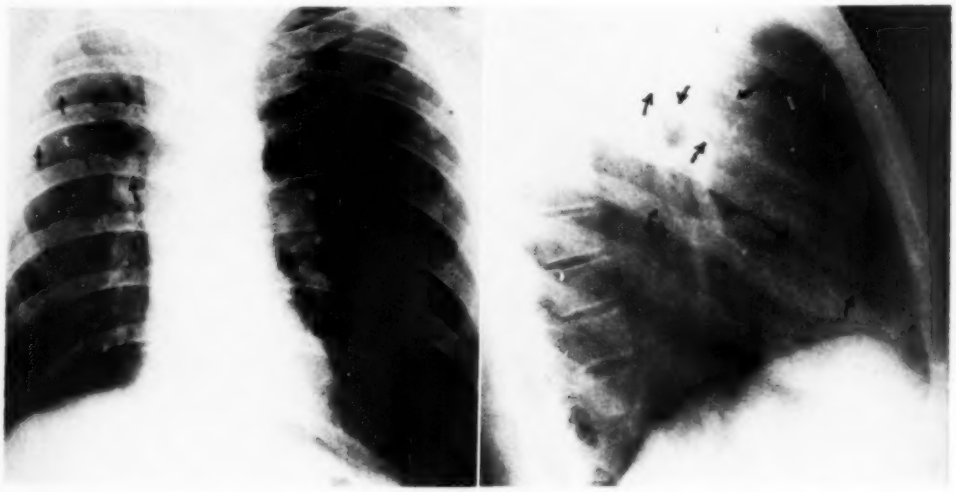

Fig. 5. Collapse of the apical segment of the right upper lobe. There is increased density in the apical portion of the right upper lobe, with fairly good aeration of the lower portion. In the postero-anterior view, the lower row of arrows indicates the position of the minor septum; the upper row, the position of the major septum (usually not well seen in this projection). The right hilus is elevated and the trachea is displaced somewhat toward the collapsed side. In the lateral view, the right major and minor septa are indicated by arrows. The left major septum is visualized and in normal position.

Right upper lobectomy. The apical segment of the right upper lobe was found to be atelectatic.

Histopathology: Chronic pneumonitis and slight bronchiectasis.

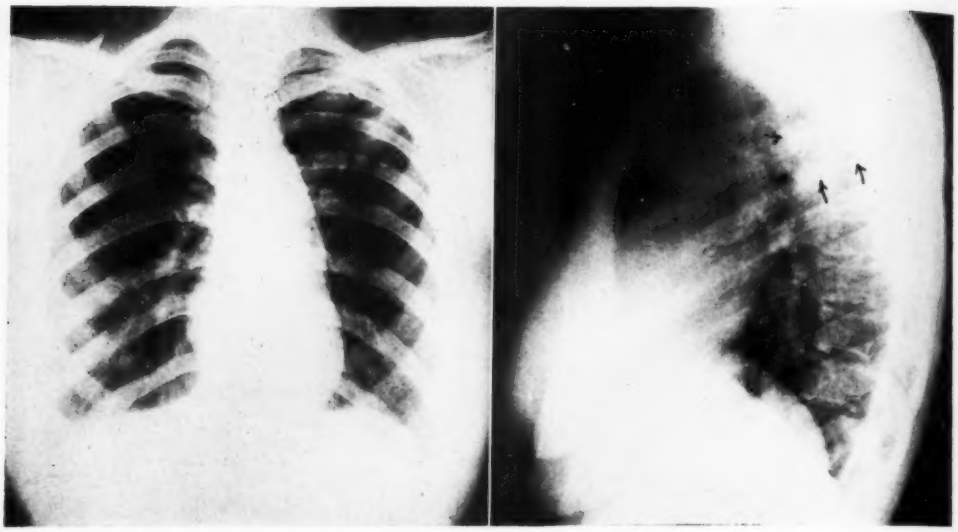

Fig. 6. Collapse of the posterosuperior segment of the left upper lobe. The shadow of increased density is seen to lie farther laterally than that usually seen in collapse of an apical segment. In the lateral view, the area of density lies against the major septum, which has not been appreciably displaced.
Left upper lobectomy. Segmental collapse was demonstrated at operation.
Histopathology: Tuberculosis.

The upper mediastinum, and especially the trachea, often show slight to moderate displacement toward the collapsed side. Tracheal displacement, even though it is slight, when seen in association with the other signs mentioned above, may be a valuable adjunct in the diagnosis of collapse of an upper lobe. The mediastinal displacement is seldom as marked as in collapse of a lower lobe and, as a rule, the lower part of the mediastinum and the heart maintain their normal position. The appearance of the intercostal spaces usually shows little or no change from normal.

The diaphragm may show slight, but seldom marked, elevation and limitation of motion in collapse of an upper lobe. It should be mentioned, however, that a neoplasm in an upper lobe frequently produces phrenic nerve paralysis as an early manifestation, in which case the diaphragm will show true paradoxical motion.

Any change in the position or contour of the septa may be of diagnostic importance in collapse of an upper lobe as it is in collapse of other lobes. When the entire upper lobe is collapsed, the major septum, while often retaining its normal contour, is displaced anteriorly. It may lie nearly against the anterior chest wall so that its uppermost portion must rise to the region usually occupied by the apex of the lung. In collapse of a right upper lobe, the minor septum may extend to the extreme top of the chest, and its shadow be assimilated with that of the apical pleura. If this occurs, the major septum will extend to the extreme apex of the right pleural cavity, and all of the aerated lung anterior to it will be right middle lobe, which will have expanded to occupy a large part of the area previously filled by the upper lobe.

As has been noted, collapse of an upper lobe can be confused with lesions of the mediastinum and aorta. This is largely due to the appearance of the shadow of increased density. If the other signs of collapse of an upper lobe, which have been described, are borne in mind, a mistaken diagnosis will be less likely.

SEGMENTAL COLLAPSE OF AN UPPER LOBE

The appearance of collapse in the lingula of the left upper lobe has been described

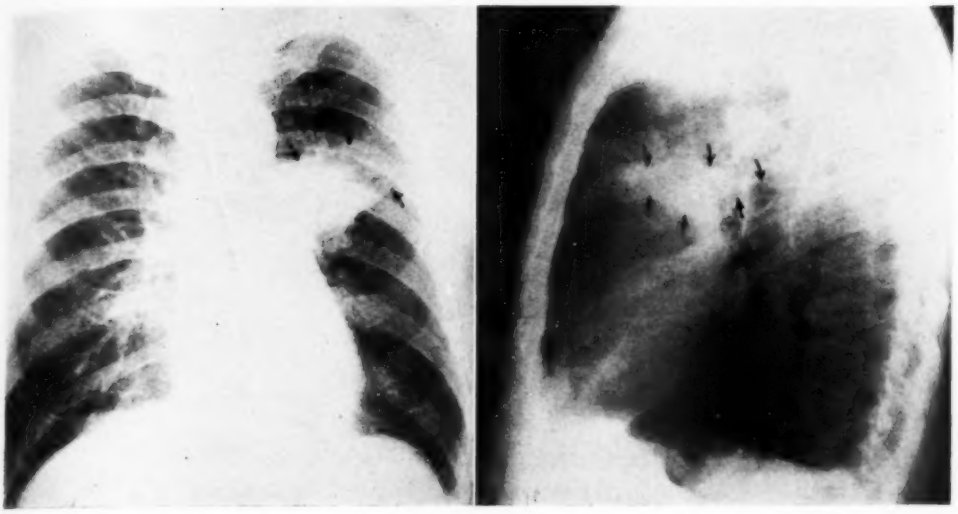

Fig. 7. Segmental collapse of the left upper lobe involving the antero-inferior, lateral, and lingular segments. The shadow of increased density, outlined by arrows, overlies the left hilus. There is no appreciable displacement of the trachea or mediastinum. The lateral view shows the shadow of density as well as the marked upward displacement of the inferior portion of the major septum (lower anterior two arrows).
Left pneumonectomy.
Histopathology: Epidermoid carcinoma, grade II.

elsewhere. For practical purposes the remaining segments are common to both the right and left upper lobes. They are usually recognized as the apical portion, the antero-inferior portion, the posterosuperior portion, and the lateral or axillary portion. Each of these divisions is supplied by a branch from the upper lobe bronchus except the axillary segment, which is usually supplied by two somewhat smaller bronchi—in the majority of cases subdivisions of the bronchi to the posterosuperior and antero-inferior segments. In some cases, however, either the anterior branch or the posterior branch to the axillary portion of an upper lobe may be represented as a major subdivision arising directly from the upper lobe bronchus. It should be noted that on the left side the bronchus to the posterosuperior segment in many cases arises from the bronchus to the apical segment rather than directly from the upper lobe bronchus. Several other minor variations in the distribution of the bronchi to the upper lobes may occur, but further discussion is beyond the scope of this paper.

A collapsed apical segment (the segment most frequently involved in partial collapse of an upper lobe if the lingula is excluded) stands out as an area of increased density anteriorly and against the mediastinum. The adjacent segments of the upper lobe are aerated, allowing visualization of the major septa and, on the right, of the minor septum. This differs from collapse of an entire upper lobe, in which the septa are blended with the shadow of increased density.

In collapse of the posterosuperior portion of an upper lobe, the shadow of density is seen to lie posteriorly and against the major septum, which forms its posterior margin, and somewhat laterally and superiorly. It is apparent, however, that the apical segment above is aerated.

The antero-inferior segment, when collapsed, casts a shadow which on the right is bounded inferiorly by the minor septum and extends anteriorly from approximately the mid chest to the anterior chest wall. The septum tends to be slightly elevated. On the left, the location of the shadow is similar, but there is no sharply defined in-

Fig. 8. Segmental collapse of the right upper lobe involving the antero-inferior and axillary segments. The band-like shadow of increased density extends laterally from the right hilus. Neither the hilus nor the minor septum is appreciably elevated. In the lateral view, the shadow of density is clearly demonstrated. The sharply defined inferior margin represents the location of the minor septum.

Right upper lobectomy.

Histopathology: Benign adenoma. The parenchyma of the antero-inferior and lateral segments of the lobe was collapsed.

ferior margin, due to the absence of a minor septum. Aerated upper lobe is seen to lie above the shadow, whether the collapsed segment is on the right or the left side.

Collapse of the axillary portion of an upper lobe is usually associated with collapse of either the antero-inferior or the posterosuperior portion, or both. If the axillary segment alone is involved, the shadow, as seen in the postero-anterior view, is somewhat triangular and is located laterally against the chest wall with a sharp inferior margin on the right due to the minor septum, the lateral portion of which is somewhat elevated. The posterior margin of the shadow is also sharply defined, as the major septum forms the posterior boundary. The findings on the left side are similar except that, as in collapse of other segments, the minor septum is absent. If the axillary segment is collapsed in combination with other segments, the resultant shadow will appear as a fusion of the shadows already described.

In general, segmental collapse of an upper lobe produces variable degrees of elevation of the hilus, but this is not as marked as in complete upper lobe collapse. The degree of elevation depends upon the segment in which collapse occurs, being greatest when the apical and least when the antero-inferior segment is involved.

The major septum shifts anteriorly from its normal position, the extent of the shift being dependent upon the degree of collapse and the segment involved. It has seemed that those segments lying more anteriorly cause a greater shift than those lying posteriorly, but this appearance may be due to difference in the bulk of tissue involved. In some instances there may be no apparent anterior displacement of the septum as a whole, but its accentuated anterior convexity will suggest a decrease in the size of the adjoining segment.

Displacement of the trachea and other superior mediastinal contents is usually not as marked in segmental as in complete collapse of an upper lobe. Although displacement may be considerable when an

apical segment is collapsed, it is much less when the collapse is confined to one or more of the other segments. Segmental collapse produces little if any change in the position or motion of the diaphragm and, because only a small unit of lung is involved, the emphysema in adjacent pulmonary tissue is usually not striking.

CONCLUSIONS

Collapse of an upper lobe is frequently not recognized because its roentgenologic appearance is not well known and the criteria by which collapse has formerly been characterized are less applicable to an upper lobe than to a lower lobe or the entire lung.

Collapse of an upper lobe produces a rather characteristic shadow of increased density lying anteromedially. When this shadow is associated with other signs indicating a decrease in the size of the lobe, such as anterior displacement of the major septum and elevation of the hilus, collapse should not be confused with other lesions in the chest.

NOTE: The close co-operation between the Departments of Surgery, Pathology, and Radiology made this study possible, and particular acknowledgment is due Dr. Richard H. Sweet and Dr. Ronald C. Sniffen.

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Pantopaque Myelography: Correlation of Roentgenologic and Neurologic Findings[1]

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CONTRAST myelography has been practised for the past twenty-five years with various media and technics. Dandy (5) was the first to employ air for the purpose, and Coggeshall and von Storch (4) and Chamberlain and Young (3) were among the early and most enthusiastic advocates of air as a medium. Chamberlain and Young found that "in each case in which operation was performed, the exact level of the lesion determined by myelographic examination was verified by laminectomy." Camp (1) also reported on the use of air. He stated that the positive findings were 90 per cent accurate, but 74 per cent of those operated upon after a negative myelographic examination proved actually to have lesions of the spinal canal. Hampton and Robinson (8) and Camp and Addington (2) are among the advocates of lipiodol for myelography, Hampton (7) claiming 93 per cent accuracy for that medium. Thorotrast has been employed by Nosik and Mortensen (10, 11). In a recent communication, Dandy (6) recommended establishing a diagnosis on the clinical and roentgenologic findings, without contrast material. The advantages and disadvantages of the various procedures have been well summarized by Pugh (12).

The earliest use of pantopaque[2] for myelography is credited to Garvey and Jones (15) of Strong Memorial Hospital, Rochester, N. Y., in 1940 and 1941, after extensive animal experimentation. The results of these early clinical trials were summarized by Warren before the Harvey Cushing Society in May 1942. Pantopaque for myelographic purposes was made available to the Armed Services in 1942 and has been used since then by the neurosurgical service of the National Naval Medical Center, Bethesda, Md.

TABLE I: TRAUMA CONSIDERED BY THE PATIENT TO HAVE CAUSED SYMPTOMS

	Patients	Protruded Disks
Lifting heavy objects	15	15
Falls from ladders, down hatch, or on wet decks	15	9
Calisthenics, running obstacle course, drilling, etc	9	9
Slipping on wet deck or in shower, but without fall	5	4
Carrying heavy objects or patients	5	3
Driving cars or trucks over rough roads	4	2
Athletics	13	11
Playing football (3 patients, 2 disks)		
Playing basketball (1 patient, 0 disks)		
Playing soccer (1 patient, 1 disk)		
Playing golf (1 patient, 1 disk)		
Swimming and diving (3 patients, 3 disks)		
Wrestling (3 patients, 3 disks)		
Bowling (1 patient, 1 disk)		
Landing from parachute jump	1	1
Cranking airplane motor	1	1
Other injuries	4	4
No definite trauma recalled	28	20
	100	79

We were eager to employ this new contrast medium but agreed that it should be used only as an adjunct in the diagnosis and localization of lesions and that a negative myelographic report would not deter exploration if this were warranted on the basis of the clinical examination.

For the purpose of this study we have analyzed 100 consecutive cases on the neurosurgical service with a provisional clinical diagnosis of protruded intervertebral disk. Pantopaque myelography was performed on nearly all patients with low back and sciatic pain in which this condi-

[1] From the Department of Radiology (Captain C. F. Behrens (MC) U.S.N., Chief of Service) and the Department of Neurosurgery (Captain W. McK. Craig (MC) U.S.N.R., Chief of Service), National Naval Medical Center, Bethesda, Md. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

[2] Pantopaque is a mixture of ethyl esters of isomeric iodophenylundecylic acids.

TABLE II: ROUTINE ROENTGEN FINDINGS IN 100 PATIENTS

					Patients
I.	Anomalies (spina bifida, lumbarization, asymmetrical development of 5th lumbar vertebra, etc.)				18
	A. Explored, disk removed				13
	B. Explored, no disk found				3
	C. Not explored				2
II.	Narrowing of intervertebral cartilage space				12
	A. Narrow L4-L5 space, disk removed				7
	B. Narrow L5-S1 space, disk removed				4
	C. Narrow L2-L3 space, not explored				1
III.	List of lumbar vertebrae				47
	A. List associated with disk				38
	List to right			20	
	Location of disk—Right	Left	Mid-line		
	a. L4-L5 2	10	3		
	b. L5-S1 2	3	0		
	List to left			18	
	Location of disk—Right	Left	Mid-line		
	a. L4-L5 4	2	0		
	b. L5-S1 7	5	0		
	B. List not associated with disk				9
IV.	Loss of lumbar lordotic curve				27
	A. Associated with disk				22
	B. Not associated with disk				5
V.	Reaction of vertebral bodies adjacent to cartilage spaces (sclerosis, hypertrophic fringe formation, etc.)				10
	A. Associated with disk				6
	B. Not associated with disk				4

tion was suspected. It is considered by some neurosurgeons that a protruded disk produces signs and symptoms so diagnostic that myelography is unnecessary. The danger of this assumption is apparent since tumors of the cauda equina are not uncommon and, when small, may produce signs and symptoms indistinguishable from those due to disk protrusion.

It is not within the scope of the present report to discuss in detail the clinical symptoms or the objective neurologic findings of the protruded intervertebral disk. The effect of trauma as an etiologic factor and the duration of symptoms are of interest, however, because we are dealing with naval personnel. In 50 per cent of our cases six months or less had elapsed from onset of symptoms to hospital admission; 70 per cent of the patients had had symptoms for one year or less. The type of trauma considered by the patient to have led to the onset of symptoms is of interest since, with few exceptions, the activities peculiar to naval service were not responsible (Table I).

ROUTINE ROENTGEN STUDY

A preliminary roentgenologic study of the lumbosacral area was carried out in all cases. Each set of films was reviewed for evidence of abnormalities as recorded in Table II, and these findings have been correlated with the surgical observations. The most common abnormalities noted were a list of the lumbar vertebrae to the right or left, present in 47 instances, and a loss of the normal lumbar lordotic curve, in 27 instances. A protruded disk is not precluded by absence of a list, but its presence does make the diagnosis somewhat more likely. List of the spine away from the protruded disk was only slightly more common than toward the side of the protrusion. Protruded disks were found in 22 of the 27 patients showing straightening of the lumbar spine. Those patients having tumors showed no decrease of the lumbar curve except in one instance in which both a tumor and a protruded disk were present. There were only 12 instances of narrowing of the intervertebral cartilage space, and 11 of these were found to be associated with disk protrusion, while the other patient was not explored. Bony proliferation and narrowing of the intervertebral cartilage spaces were present, almost without exception, in patients who had had symptoms for over three years. These findings were observed in older persons,

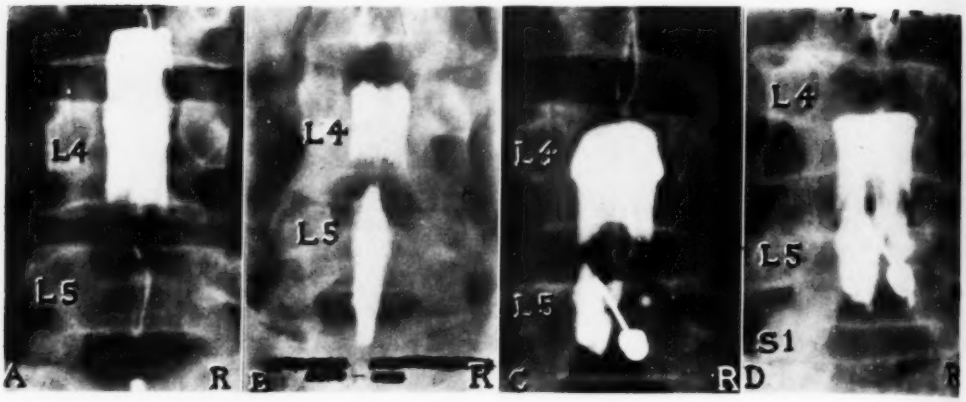

Fig. 1. Mid-line protruded disks.

A. Complete obstruction due to large mid-line protrusion at L4-L5.
B. Same case as A. Following cough the pantopaque has passed the obstruction, demonstrating the excellent fluidity of this medium. A large protruded disk with its bulk extending toward the right was removed.
C. Large mid-line defect due to protruded disk at L4-L5. History of disk removal elsewhere two years previously at L5-S1.
D. Same case as C. Coughing has produced filling, demonstrating a division of the opaque column at the site of the mid-line protrusion. It was impossible to fill the space at L5-S1. A large mid-line protruded disk was found at L4-L5 and adhesions were noted about L5-S1 at the site of the previous transdural operation.

but most of those constituting this series were between twenty and thirty years of age. The common anomalies of the lumbosacral area, as spina bifida occulta, lumbarization, and sacralization, were noted in 17 instances, and the presence of such defects has no bearing on the incidence of protruded disks.

The most common roentgen findings associated with a protruded disk are narrowing of the intervertebral cartilage spaces and straightening of the lumbar spine, but these occur in relatively few patients. Spondylolisthesis was detected only once, and in that instance it was associated with a protruded disk.

TECHNIC OF PANTOPAQUE INJECTION

For the performance of lumbar myelography, the patient is placed prone on a tilting fluoroscopic table with a folded pillow beneath the lower abdomen. Another pillow is placed beneath the feet and ankles. This position favors accurate mid-line insertion of the spinal needle. Very obese or poorly relaxed patients are placed in the usual lateral position for lumbar puncture and then gently rolled into the prone position.

The skin is painted with an antiseptic solution and the area of injection is draped with sterile towels. Procaine, 2 per cent, is used to infiltrate the skin, subcutaneous tissue, and interspinous ligament. A short, beveled, 18-gauge lumbar puncture needle is inserted either at the fourth and fifth lumbar or the fifth lumbar and first sacral interspace. We attempt to avoid inserting the needle at the clinical level of the protruded disk. For example, in patients exhibiting the signs of first sacral root compression, the lumbar puncture should be performed at the fourth and fifth lumbar interspace. Before passing the needle point into the subarachnoid space, it is advantageous to elevate the head of the table from 20 to 30 degrees above the horizontal. When a free flow of cerebrospinal fluid has been obtained, 3 c.c. of pantopaque are slowly injected. Care should be taken to avoid admixture of air and oil during the withdrawal of the pantopaque from the ampule and during the injection. Failure to observe this precaution may lead to globule formation, which will render the subsequent study and removal more difficult. Following the injection, the stylet is replaced in the needle

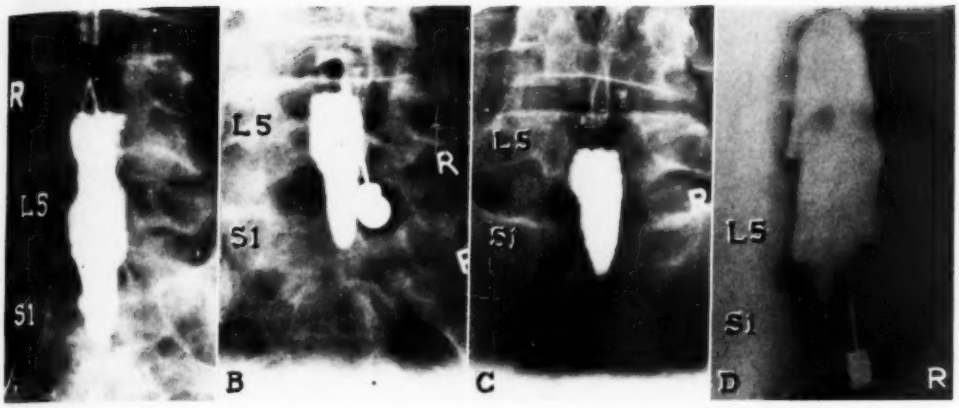

Fig. 2. Protruded disks at the lumbosacral junction.

A. Myelogram positive for protruded disk on the right at L5-S1. Fluoroscopically this part of the column remained rigid during coughing while the rest of the column showed distensibility. Confirmed at operation.

B. Myelogram positive for protruded disk at L5-S1 on the left. Note the wide space between the column and the pedicle with slight indentation of the column and displacement of the column to the right. A broad, flat, soft and degenerated disk had elevated and displaced the fifth lumbar root.

C. Myelogram positive for a protruded disk at L5-S1 on the left. This deformity was slight but constant. A large protruded disk was found.

D. Myelogram positive for large protruded mass at L5-S1 on the right. The needle was inserted at the level of the disk. The pantopaque could not be aspirated. A large protruded disk was found lateral to and beneath the first sacral root, displacing it mesially.

and the operative field is covered with a sterile towel. The patient is then ready for fluoroscopy.

FLUOROSCOPY AND RADIOGRAPHY

The fluoroscopic study is performed only after adequate dark adaptation. Since the injection was done with the head of the table elevated 20 to 30 degrees from the horizontal, the pantopaque will be pooled in the region of the third to fifth lumbar vertebrae. The table is elevated slowly so that the column is moved to the level of the interspace between the fourth and fifth lumbar vertebrae, if not already there, and a spot film is exposed. The table is then elevated to bring the opaque material to the space between the fifth lumbar and first sacral vertebra, and a second film is exposed. These films are exposed early in the course of the examination with as little agitation of the opaque material as possible, to prevent globule formation. The table is elevated until the patient is erect and he is asked to cough in order that the tip of the subarachnoid sac may be observed and that any resistance offered to the lateral thrust of the column incident to coughing may be noted. The table is then lowered and the fifth lumbar and first sacral and the fourth and fifth lumbar interspaces are studied in greater detail, for any deformity of the subarachnoid space or asymmetry of the axillary sleeves or pouches. Defects should be constant and should be demonstrable whether the opaque column is caused to flow cephalad or caudad.

If there is any suggestion of a defect, it is observed more fully by turning the patient into both 30-degree oblique positions. The lateral position was used in our early cases but was soon discarded because it furnished no additional information. The opaque material is caused to flow as far cephalad as the tenth dorsal vertebra in searching for tumors in the region of the lower end of the cord or cauda equina. This procedure has been performed as a rigid routine, and its value is attested by the finding of five tumors below the level of the tenth dorsal vertebra and, in one instance, a protruded disk and a tumor in the same patient.

The speed of tilt of the fluoroscopic table

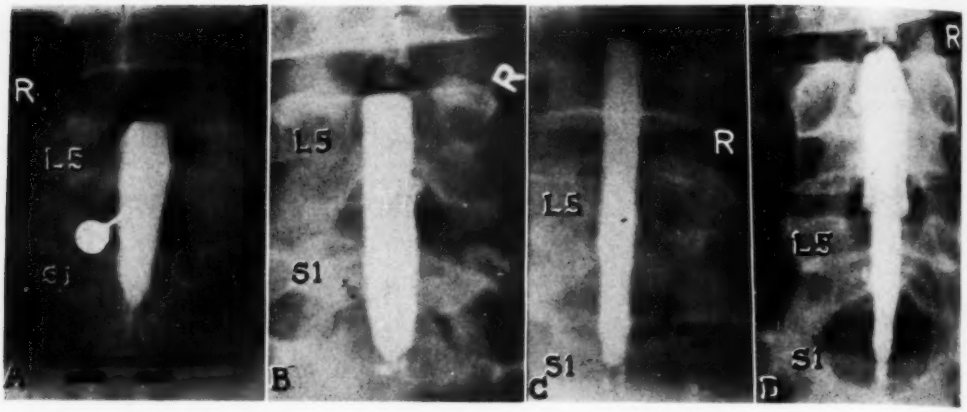

Fig. 3. Myelograms considered negative but disks were found at operation.

A. One large and two small pieces of protruded fibrocartilage were found at L5-S1 on the left. The root was displaced mesially and covered with a membrane.

B. A disk had protruded through a posterolateral defect at L5-S1 on the right, displacing the root mesially.

C. A large lateral conical mass had protruded through a posterolateral defect at L5-S1 on the right, between the dura and the nerve root.

D. A large protruded mass of degenerated fibrocartilage was found elevating the root on the right side at L5-S1.

is important. We have recently acquired a table with such rapid speed of tilt that globule formation almost always results. Proper adjustment of the pillows so that the patient assumes a modified knee-chest position tends to straighten the lumbar spine and thus prevents too rapid flowing of the opaque material in the dorsolumbar area.

The pillow is allowed to remain under the lower abdomen unless we fail to detect the presence of a defect, in which event it is usually removed. The pillow increases the intra-abdominal pressure, which in turn increases the venous pressure in the neural canal, and this may result in narrowing of the subarachnoid space. In some instances this can be readily demonstrated by having the patient breathe deeply or strain. The column may be considerably narrowed during inspiration and widened during expiration. In unusually tense or poorly relaxed patients the column tends to be narrow at first but, as the examination proceeds, the maximum width is soon noted.

In the anteroposterior view the width of the spinal canal can be accurately measured. The mesial borders of the pedicles correspond to the most lateral borders of the bony canal. The normal subarachnoid space usually fills a considerable portion of the canal, but there is a great deal of variation in this respect, and occasionally the space is very narrow. In addition to the normal width of the subarachnoid space there are regularly placed lateral projections opposite each vertebra, symmetrical on the two sides and best noted in the lumbosacral area. These lateral projections, called axillary pouches, correspond to the mesial borders of the nerve roots as they emerge from the subarachnoid space and the closely approximated dural sac. Often the nerve sheath or root sleeve is filled with the opaque medium for a short distance after the nerve has passed through the dura. Deformity of this sleeve is often of great help in detecting a lesion.

Many myelograms which were at first thought to be negative were found not to be negative when greater care was exercised in making the fluoroscopic study and in evaluating the roentgen findings. Moderate-sized protrusions, however, at the fourth and fifth lumbar or, in particular, at the fifth lumbar and first sacral interspace may frequently escape detection. This is true in patients having a narrow subarachnoid space, or where at the fifth lumbar and

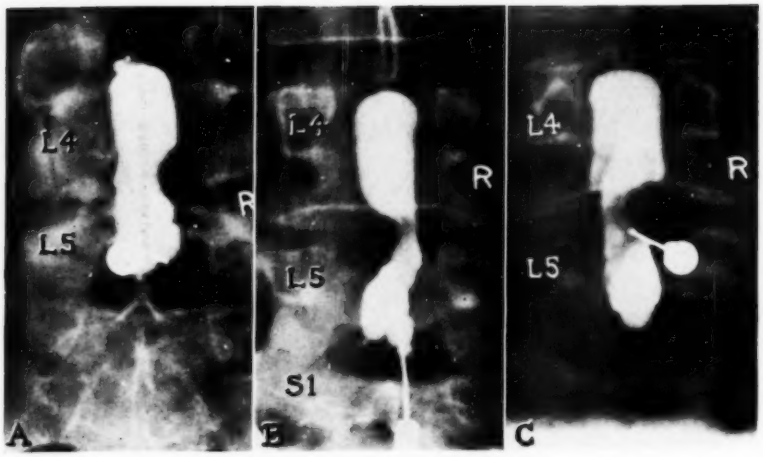

Fig. 4. Posterolateral protrusions. Disks of this type can be easily demonstrated by any contrast medium, and the clinical findings are usually typical. Only a small percentage of protruded disk defects are of this variety.

A. A large posterolateral disk on the right at L4-L5 was removed.
B. Defect at L4-L5 on the left. Three large loose pieces of fibrocartilage were found, one of which had become displaced down along the fifth root to the L5-S1 interspace.
C. Posterolateral defect on the right at L4-L5 was found to be due to a large protruded mass.

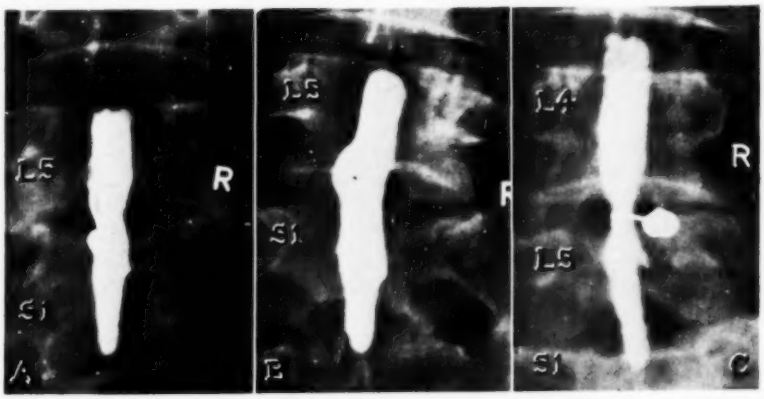

Fig. 5. Illustrating the slight deformity of the subarachnoid space when the disk is situated laterally. The nerve root may be displaced mesially against the opaque column to account for the defect. If the nerve root is displaced laterally against the pedicle, there may be typical symptoms without any deformity of the subarachnoid space.

A. Myelogram questionable at L5-S1 on the right. A large soft protruded disk was found at this level.
B. Slight but constant defect at L5-S1 on the right. A protruded disk was found compressing the nerve root mesially.
C. Myelogram questionable at L4-L5 on the left. A mass of stringy fibrocartilage was found protruding through a defect in the annulus fibrosus at this level.

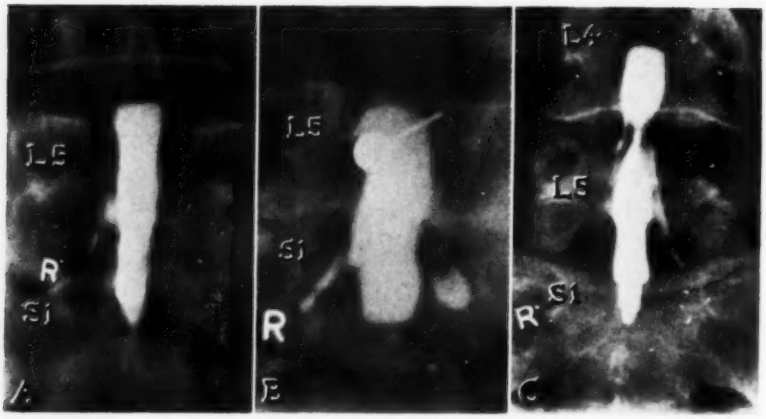

Fig. 6. Deformity of the axillary pouches or root sleeves.

A. Myelogram questionable because of the narrow column and the asymmetrically filled axillary pouch and root sleeve. A small protruded disk was found at L5-S1 on the left.

B. Myelogram shows defect at L5-S1 on the left, due to compression of the nerve root mesially and distention of the root sleeve. A large protruded mass was found adherent to the defect in the annulus and to the root, which was displaced toward the mid-line.

C. Myelogram shows mid-line defect at L4-L5 and asymmetrical filling of the root sleeves at L5-S1. A large mid-line protruded disk was removed from L4-L5. The lumbosacral space was found to be normal.

first sacral interspace a large portion of the involved nerve is outside the subarachnoid space. Partial obliteration of an axillary pouch or slight elevation of a sleeve or pouch without any indentation of the subarachnoid space may be sufficient to establish the diagnosis. These clues should be sought fluoroscopically. At times the opaque column will deviate at a certain point and there will be a visual impression of the medium flowing away from the side of the lesion more quickly than it does on the opposite side, suggesting elevation of the ventral aspect of the subarachnoid space. Only rarely does the subarachnoid space fail to extend beyond the lumbosacral interspace when the patient is examined erect and after coughing. The value of having the patient cough cannot be overemphasized. The pantopaque will flow into the sleeves and pouches through small openings because of its low viscosity.

During the fluoroscopic study at least six films are exposed to demonstrate the defect or to record the appearance of the subarachnoid space for further study. The apparatus should be such that it will permit rapid changing from fluoroscopy to radiography. Since the spinal needle is left in place during the fluoroscopic examination, it should be possible to lock the screen at a safe distance to prevent contact with the needle.

REMOVAL OF THE PANTOPAQUE

When the roentgenographic studies have been completed, the pantopaque is pooled at the tip of the needle under fluoroscopic visualization in the manner recommended by Kubik and Hampton (9) for lipiodol. The oil is aspirated with gentle suction into a 2-c.c. hypodermic syringe. Larger syringes are to be avoided as they are apt to produce too great a negative pressure, which leads either to breaking of the oil column or the sucking up of the nerve roots or membranes across the opening in the needle. With the small syringe it is not uncommon to recover practically all the opaque material at the first aspiration. When aspiration is incomplete or unsatisfactory, the fluoroscopist relocates the pantopaque adjacent to the needle tip. If cerebrospinal fluid is obtained despite

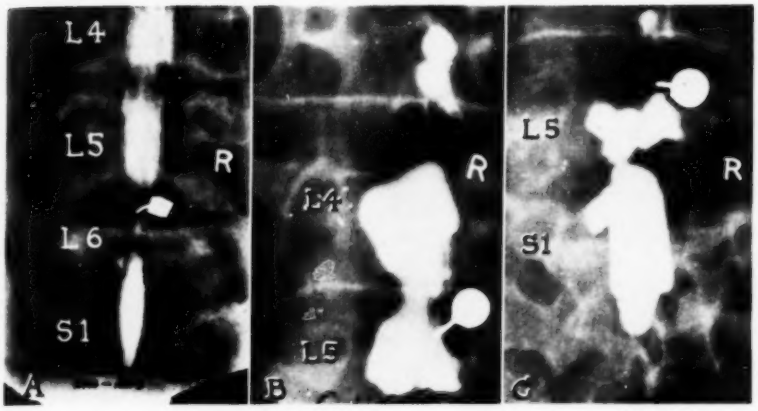

Fig. 7. Multiple disk protrusions.

A. This patient had six lumbar vertebrae. There are defects at L4-L5 on the right and at L5-L6 in the mid-line. The lumbosacral space appears normal. A small protruded disk was removed on the right at L4-L5, and a large soft mass protruding in the mid-line was found at L5-L6.

B. and C (same patient). Defects noted at L4-L5 on the left and at L5-S1 on the right. Protruded disks found at both sites.

TABLE III: REMOVAL OF PANTOPAQUE AT COMPLETION OF MYELOGRAPHIC STUDY

	Patients
Pantopaque injected	87
50% or less removed (includes 5 extra-arachnoidal injections)	10
50% to 90% removed	12
90% to 95% removed	13
95% and over removed	39
No films exposed after aspiration	13
	87

satisfactory pooling of the pantopaque, the needle is advanced until the point comes to rest in the mass of the heavier oil. Following the aspiration of the pantopaque, the needle is withdrawn and the completeness of the removal is checked by fluoroscopy and a post-aspiration film. The site of injection is covered with a sterile dressing. The entire time employed in the myelographic procedure averages twenty minutes. The patient remains flat in bed until the following day, when normal activities may be resumed.

In 70 per cent of the patients, 90 per cent or more of the opaque material was removed (Table III). It was impossible to withdraw any appreciable amount in the five instances of extra-arachnoidal injection. The factors which interfere with satisfactory removal of the pantopaque from the subarachnoid space are placing the needle at the site of the protrusion, or at a nerve sleeve, or at the periphery of the subarachnoid space so that the membranes fall against the needle opening when aspiration is attempted (Fig. 11).

SEQUELAE AND ABSORBABILITY OF PANTOPAQUE

Toxic manifestations or signs of root irritation have not been observed. The headache complained of is no more than might be anticipated in routine lumbar puncture with removal of fluid for diagnostic purposes. We have been unable to follow any of our cases in which we failed to remove the pantopaque from the subarachnoid space for a sufficiently long time to determine absorbability. Ramsey, French, and Strain (13) report that the approximate rate of absorption is 1 c.c. per year.

SURGICAL TECHNIC

The operative removal of a protruded intervertebral disk is accomplished through a unilateral approach with sacrifice of a minimal amount of bone. Adequate exposure is essential and bone is removed until this is accomplished; usually a partial hemilaminectomy is sufficient. Careful

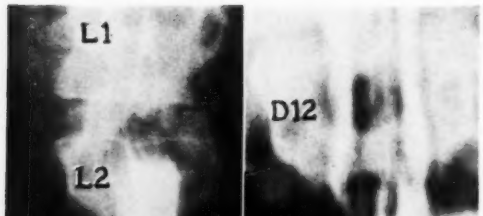

Fig. 8. Defects produced in the opaque column by tumors.

A. Complete obstruction caused by an intradural neurofibroma at L1-L2.

B. Defect due to an intradural meningioma at D12-L1.

dissection of the nerve root from the underlying disk and gentle retraction allow removal of the protruded cartilaginous mass without trauma to the nerve. The operation may be done with the patient in the horizontal or sitting position (14). When the myelogram reveals a large defect, the usual prone position is employed. We believe, however, that with a minimal defect or with no apparent myelographic change but a satisfactory clinical history, better surgical results are obtained with the patient seated. The weight of the body and the mild flexion of the trunk in this position tend to exaggerate the protrusion, thus reducing the number of so-called "concealed disks."

Spinal anesthesia is used in all cases. A mixture of pontocaine and glucose gives very satisfactory results with the patient in the sitting position, since it is heavier than spinal fluid. Muscular relaxation is improved with spinal anesthesia, thus eliminating the forceful retraction of the sacrospinalis muscle mass which is often necessary when a general anesthetic is employed. The nerve root is retracted mesially and a circular or cruciate incision is made in the posterior longitudinal ligament overlying the protrusion. The disk material is removed with a pituitary forceps. No attempt is made to remove the entire interior of the disk, but it is likely that partial removal beneath the site of the protrusion affords greater decompression of the nerve root and minimizes the possibility of recurrence. Postoperative care is symptomatic. Usually opiates are required during the first twenty-four hours because of discomfort at the site of operation. The patient is up on the third day and is fully ambulatory after one week. No postoperative back support is necessary.

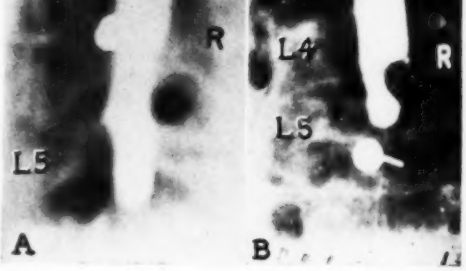

Fig. 9. Deformity of the pantopaque column not produced by disks or tumors.

A. Note defect in the lamina at L4-L5 on the right. A protruded disk was removed at this interspace one year previously. The myelogram suggested that another protrusion had occurred. Exploration revealed the tear in the annulus with considerable scarring about the area, but no new protrusions were discovered. We have recently examined two patients after disks had been removed, by using the pantopaque which was not successfully aspirated. In both instances considerable deformity of the subarachnoid space was noted at the site of the protrusion.

B. A defect is noted at L4-L5 on the right. At the exploration a hole was found in the body of the fourth lumbar vertebra about 1 cm. above the interspace, into which the forceps could be dropped easily. There was some swelling of the nerve root but no rupture of the annulus could be detected and no disk was found. To make certain that the correct interspace was explored, the space above and the space below were also explored, with negative findings.

MYELOGRAPHIC FINDINGS

(Figs. 1 to 13)

The appearance of the opaque column will usually be in accord with one of the following types:

TABLE IV: ANALYSIS OF 100 CONSECUTIVE CASES OF LOW BACK DISABILITY WITH A PROVISIONAL DIAGNOSIS OF PROTRUDED DISK ON ADMISSION TO THE NEUROSURGICAL SERVICE

Patients	Protruded Disk	Tumors	Operation		Myelogram			
			Positive	Negative	Positive	Negative	Questionable	Subdural Injection
46	49*	..	46	..	46	..	..	..
10	10	..	10	..	..	..	10	..
7	7	..	7	..	..	7	..	..
1	1†	1	1	..	1	..	..	..
4	..	4	4	..	4	..	..	..
2	..	..	..	2	2	..	..	..
3	..	..	No operation		3	..	..	..
9	..	..	No operation		..	9	..	..
5	4	..	4	1	..	..	..	5
13	11	..	11	2	Myelography not performed			
100	82	5	83	5	56	16	10	5

* Three patients with double disks demonstrated by myelography and at operation.
† One patient with disk and tumor found by myelography and surgery.

I. Mid-line defect due to rupture of the annulus fibrosus with posterior protrusion of the disk.
II. Asymmetry of the caudal end of the subarachnoid space.
III. Narrow subarachnoid space without defect.
IV. Posterolateral defects,
   (*a*) Those producing large lateral defects of the subarachnoid space.
   (*b*) Those producing very slight lateral defects of the subarachnoid space.
   (*c*) Those producing only deformity of the axillary pouches or root sleeves.
V. Obstruction due to tumors.
VI. Extra-arachnoidal injection.

DISCUSSION

Myelography not only affords an easy method of investigating the cauda equina but also allows accurate visualization of each lumbar interspace. Pantopaque has proved to be an excellent medium for this purpose and affords satisfactory contrast. Multiple protrusions have been observed when a single lesion was suspected clinically. Tumors have been found when a protruded disk was believed to be present, and in one instance a tumor and a large protruded disk were found in the same patient.

The complaints associated with protruded disks are often out of proportion to the clinical findings. Objective findings are not uncommonly vague or absent. Frequently the complaints are typical of a protruded disk but the neurologic findings are scant and indefinite. If, however, the same patient is examined a week or so later, very definite neurologic findings may be elicited, including absence or diminution of reflexes which were normal at the previous examination.

A total of 82 protruded disks were removed from 79 of the patients in our series (Table IV). Three patients each had two disks. Three patients had definite neurologic and myelographic evidence of protruded disks but were not operated upon. An operation was performed in 13 instances without myelography and in 2 of these patients findings sufficient to explain the clinical picture were lacking. Two patients had myelographic evidence of disk protrusion, but a protruded disk was not found at operation (Fig. 9). Protruded disks were either diagnosed or strongly suspected in 57 of the group of 87 patients on whom myelography was performed. In 10 of these cases the myelographic evidence alone was questionable, but its correlation with the neurologic data made an exact localization possible. In 7 instances myelographic evidence of disk protrusion was lacking. The opaque material was injected outside the subarachnoid space in 5 patients, apparently due to faulty technic.

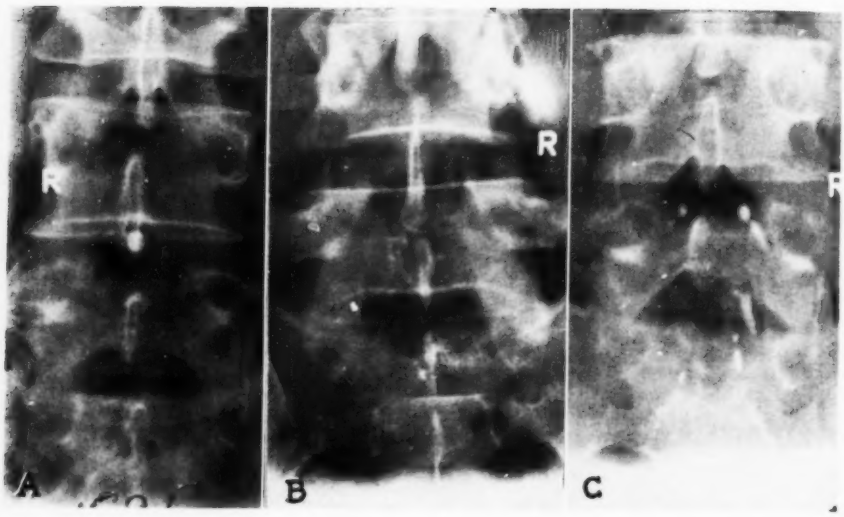

Fig. 10. Successful removal of pantopaque by aspiration.

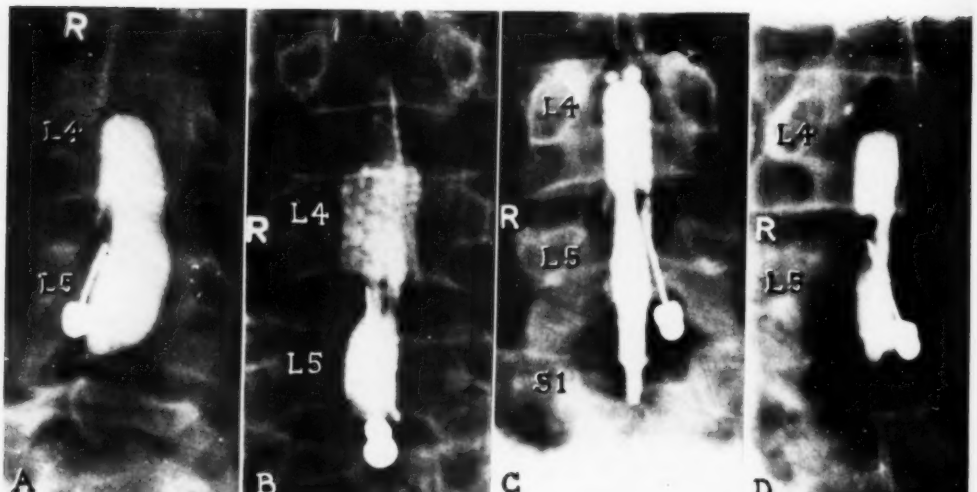

Fig. 11. Common causes of unsuccessful aspiration of pantopaque.

A. The needle was placed at the periphery of the subarachnoid space so that the meninges covered the needle opening when aspiration was attempted and none of the opaque material was recovered.

B. Only 25 per cent of the pantopaque was recovered. Note the indentation of the column at L4-L5, due to the bulge of the normal intervertebral disk. Globule formation is present.

C. The needle had been placed adjacent to the root sleeve and none of the pantopaque was recovered. This patient had sharp pain radiating down the left leg when aspiration was attempted. Note the narrow column with a wide space between the pedicles and the subarachnoid space.

D. Only a small amount of the pantopaque was recovered due to the needle having been placed adjacent to the protruded mass.

We have accumulated no evidence that such leakage follows a recent lumbar puncture and we have made no attempt to postpone myelography if lumbar puncture has recently been performed. All but one of the protruded disks were caudal to the fourth lumbar vertebra (Table V). Five tumors were found and 4 of them were above the body of the fourth lumbar vertebra and below the body of the eleventh dorsal vertebra.

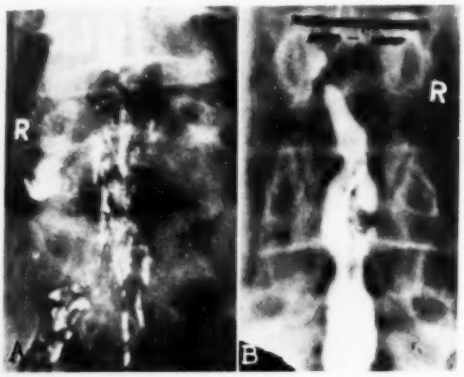

Fig. 12. Typical appearance noted after injection of pantopaque outside the subarachnoid space.

A. This was the appearance noted at the start of the fluoroscopic study. The pantopaque remained in the pattern demonstrated and none of it was recovered by attempted aspiration.

B. The opaque material remained in this compact mass and would not flow up or down the neural canal. A lateral film demonstrated that the material was confined to the dorsal part of the neural canal.

It is not the purpose of this paper to consider the instances in which the roentgenologic and neurosurgical findings were in accord but rather to re-examine those in which the roentgenologic findings were negative or questionable and the surgical findings were positive. Early in our experience with pantopaque it became evident that those persons having a narrow subarachnoid space offered the greatest diagnostic difficulties. We have reviewed the myelograms in the present series of cases and have made interpediculate measurements and measurements of the subarachnoid space at its normal width nearest to the defect. Since a cross-section of the lumbar dural sac is triangular, with the base of the triangle ventrally, the measurement of the subarachnoid space is not altered by changing the patient from the prone to the erect position. Figure 14 demonstrates the relationship of the width of the subarachnoid space to the positive operative findings. It is evident that those patients having questionable or negative myelographic findings with subsequent positive surgical findings all fall into the group having a narrow subarachnoid space. Discrepancies occurred only when the subarachnoid space measured 16

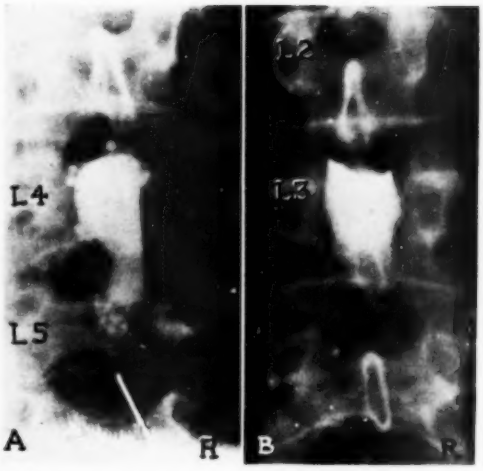

Fig. 13. Tumor of the cauda equina and a protruded disk in the same patient.

A. A large defect was demonstrated at L4-L5 on the left side.

B. Same patient as A. In the attempt to carry out our routine study of the neural canal by running the opaque material as far cephalad as the tenth dorsal vertebra, a complete obstruction was discovered at L2-L3. At operation a large posterolateral protrusion was found at L4-L5 and a neurofibroma measuring 2.5 × 1.5 × 1.5 cm. was found at L2-L3.

TABLE V: LOCATION OF PROTRUDED DISKS AND TUMORS

Protruded Disks	Right	Left	Mid-line
L3-L4	1	0	0
L4-L5	15	14	7
L5-L6	0	0	1
L5-S1	21	23	0

Tumors	Histologic Type
D12-L1	Meningioma
L1-L2	Neurofibroma
L2-L3	Neurofibroma
L3-L4	Ependymoma
L5-S1	Neuroepithelioma

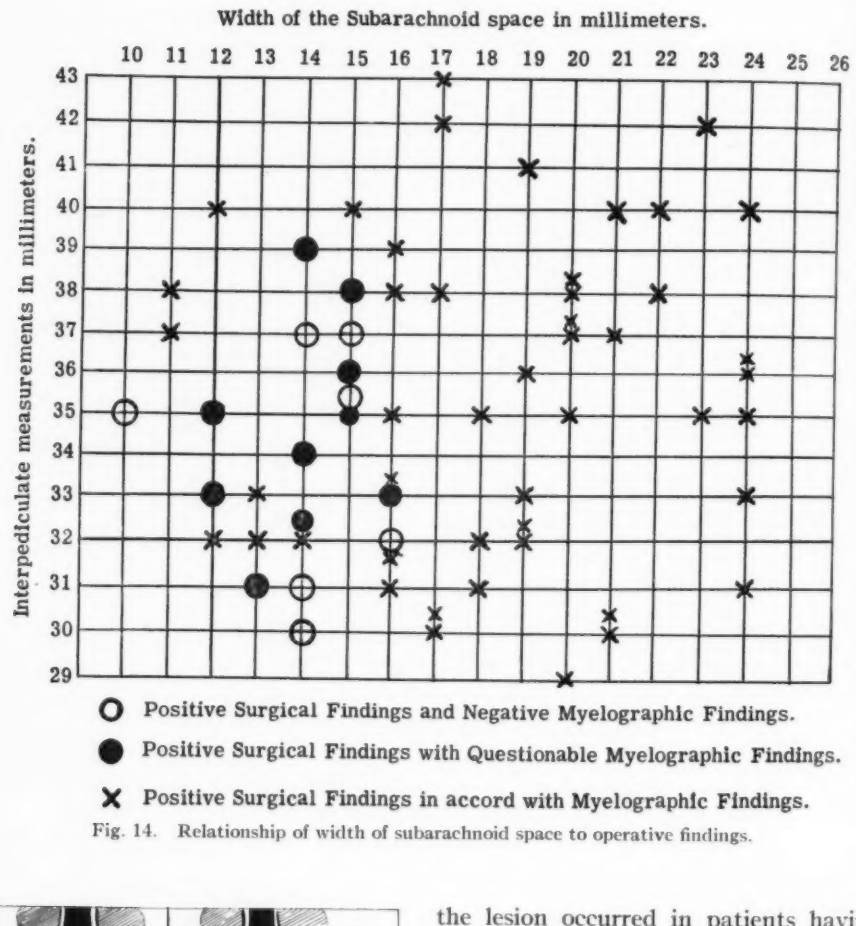
Width of the Subarachnoid space in millimeters.
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Interpediculate measurements in millimeters.
43 42 41 40 39 38 37 36 35 34 33 32 31 30 29
Positive Surgical Findings and Negative Myelographic Findings.
Positive Surgical Findings with Questionable Myelographic Findings.
Positive Surgical Findings in accord with Myelographic Findings.

Fig. 14. Relationship of width of subarachnoid space to operative findings.

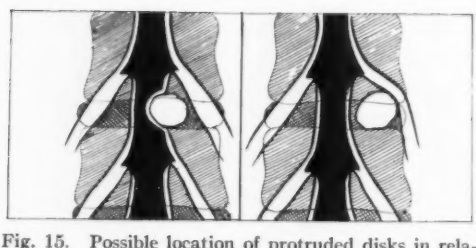

Fig. 15. Possible location of protruded disks in relation to the opaque column and nerve roots.

mm. or less. There was complete confirmation of the roentgen findings in all patients having a subarachnoid space wider than 16 mm. The interpediculate measurements have no bearing on the width of the subarachnoid space. Even with a narrow subarachnoid space, mid-line or large posterolateral protrusions offered no diagnostic difficulties. Failure to demonstrate the lesion occurred in patients having a narrow subarachnoid space and a small posterolateral protrusion which failed to indent the column of pantopaque. In addition, posterolateral protrusions which fail to encroach on the nerve sleeves or pouches, or in which these structures do not fill, will not be detected by myelography. Our explanation of the lack of positive myelographic findings in instances of narrow subarachnoid spaces is that the distance between the site of the rupture and the subarachnoid space is sufficiently great to allow moderate protrusions without indentation of the opaque column (Fig. 15).

It must be admitted that with our present technic not all protruded disks can be demonstrated. The myelographic procedure is worth while, however, in ruling out

lesions of the cord and cauda equina. This permits surgical exploration at the interspace where the disk is localized clinically. When the operation is done through a small opening, a shorter period of hospitalization is required and the future usefulness of the patient to the Navy will not be jeopardized.

CONCLUSIONS

1. Roentgenograms of the lumbosacral spine without the aid of myelography are of little definite value in the diagnosis of protruded intervertebral disks.

2. In our experience, pantopaque has been found to be a satisfactory medium for myelography because of ample contrast, lack of irritating properties, low viscosity, and ease of removal.

3. Despite the fluidity and low viscosity of the medium, which allows it to fill all irregularities of the dural sac, many protruded disks cannot be detected with our present technic.

4. Pantopaque myelography should be carried out routinely as an aid in the diagnosis and localization of protruded disks and to rule out tumors of the cord, meninges, and cauda equina.

5. It is demonstrated graphically that a negative myelogram in a patient whose subarachnoid space measures less than 16 mm. does not preclude the presence of a protruded disk.

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Pantopaque Myelography for Protruded Disks of the Lumbar Spine[1]

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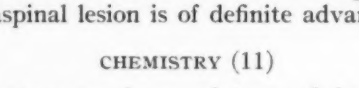
THE VALUE AND limitations of myelography for the diagnosis of intraspinal lesions are becoming well recognized. Pantopaque (6, 10) as a contrast medium was first introduced into the Army hospitals in 1942 by Spurling (9). Constant search is being maintained for a contrast medium that is innocuous, absorbable, and capable of being easily removed, so that no foreign body material may remain within the spinal canal. These demands seem to be best met at present by pantopaque. The indications for the employment of such an oil depend on the diagnostic problems at hand. Obviously its indiscriminate use is to be discouraged when an accurate diagnosis can be reached clinically. However, to have available a substance that is safe and that can aid in the determination and more accurate localization of a suspected intraspinal lesion is of definite advantage.

CHEMISTRY (11)

Pantopaque is a mixture of isomeric ethyl esters of which the principal constituent is provisionally ethyl iodophenylundecylate:



It is prepared by esterification with ethyl alcohol of the mixture of iodophenylundecylic acids obtained by direct iodination of phenylundecylic acid. The ester is purified by treatment with decolorizing agents and by distillation under reduced pressure. The final product contains 30.5 per cent of iodine in firm organic combination and has a specific gravity of 1.26 at 20° C. It is a colorless to pale yellow liquid which does not deteriorate on storage, and which may be sterilized. It is discolored, however, by exposure to sunlight. Pantopaque is deleterious to rubber articles and should not be brought in contact with them. It is practically non-miscible with water or spinal fluid.

TECHNIC

A procedure remains standard only in principle and is usually modified to meet the requirements or convenience of the operator (6, 9). The technic outlined here is in essence that being employed by many neurosurgeons in military hospitals, where it has been used for some time.

The patient is prepared by a cleansing enema six to ten hours before the examination is to be made, and aspirin 0.6 gm. (10 gr.) and seconal 0.1 gm. (1 1/2 gr.) are given two hours prior to the procedure. The lumbar area is shaved and cleansed as necessary. The patient is then placed prone on a tilting fluoroscopy table with a small pillow under the lower abdomen to facilitate spinal puncture. (If desired, a spinal puncture can be performed in the lateral recumbent position and the patient then carefully turned onto the abdomen.) The feet should be resting firmly against the foot board for support when the table is tilted downward. The lumbar spine is then prepared and draped, and novocaine is infiltrated into the interspinous space selected.

The spinal puncture is made preferably either above or below the interspace at which the lesion is suspected. The level of the suspected lesion is avoided for three reasons: (*a*) the needle may strike the lesion itself and so enhance or distort the

[1] From the Section of Neurosurgery, Bushnell General Hospital, Brigham City, Utah. Accepted for publication in December 1944.

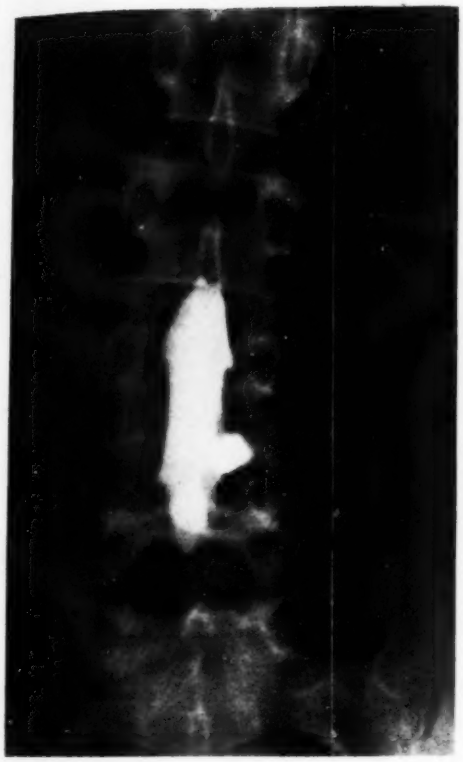


Fig. 1. Normal myelogram showing good visualization of nerve root sleeves.

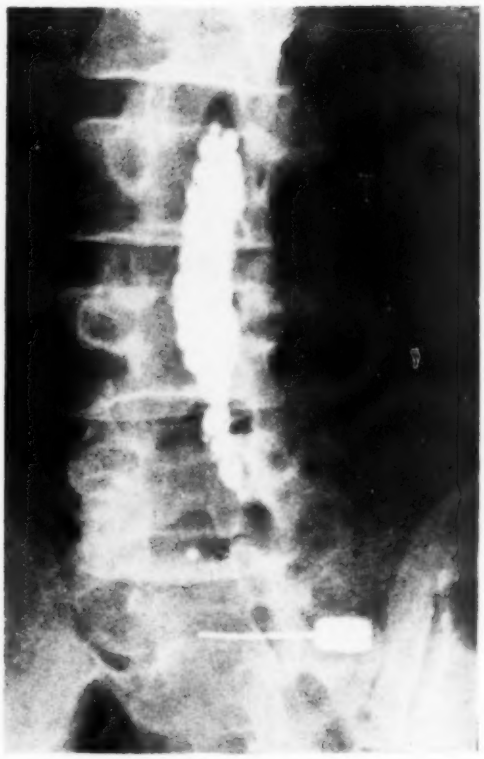


Fig. 2. Extensive globulation in an otherwise normal myelogram.

abnormality; (*b*) the injection and subsequent removal of the oil may be more difficult; (*c*) an artefact is occasionally created in the canal at the site of the puncture that might lead to an erroneous conclusion, as shown in Figure 5. The exact cause of such an artefact is not known, but it is thought to be produced by the penetration of the dorsal dural envelope by the needle, the dura being indented and pushed away from the canal wall, thus giving the appearance of an extradural mass on either side of the canal. This is particularly true if the needle is not exactly in the mid-line. Obviously, in questionable cases removal of the needle and re-examination will settle the question.

A 20-gauge lumbar puncture needle is carefully inserted into the mid-line of the spinal canal until the point just touches the ventral canal wall (to facilitate subsequent removal of the oil) and then rotated or manipulated until fluid escapes from the head of the needle, as it does readily. Five c.c. of spinal fluid are aspirated with a syringe for laboratory analysis. This helps, also, in determining a good free flow of fluid and the absence of obstruction at the needle point, conditions which are necessary for ready removal of the pantopaque at the close of the examination. The pantopaque (3 c.c.) is then taken up in a 5-c.c. Luer-Lok syringe and the syringe is locked onto the spinal needle. With firm steady pressure, the entire quantity of oil is injected under pressure just sufficient to effect its ejection into the canal in a constant stream rather than by droplets. This tends to insure the oil remaining in one large mass and there is less tendency to "globulate" in the canal (Fig. 1). The syringe is then disconnected; the stylet is

Fig 3. Pantopaque collected at the needle point, ready for removal.

inserted into the needle, which is left *in situ* and covered with a sterile towel.

Fluoroscopy is then carried out, slowly tilting the patient up or down and observing the column of oil moving along the canal. It is important to tilt the patient slowly, since rapid movement of the oil tends to cause it to break up into globules (6) (Fig. 2). The maximum information is obtained from the examination by observing the "head" of the column of oil as it becomes deflected by any abnormal mass lying within the spinal canal. Normally, the oil flows smoothly in the canal and fills out the root sleeves well. For the confirmation of a defect, the patient can be rotated from side to side, particularly in the presence of lesions lying along the ventral canal. When a lesion is adequately demonstrated, proper views are made on films and examination is then complete.

The following factors were employed for fluoroscopy: 0.5 mm. aluminum inherent in the tube, with 5 ma. at 70 kv.p. In the radiographic technic for the posteroanterior view the factors were: filter, 1.5 mm. aluminum inherent in the tube; target distance 36 inches; 100 ma.; 1 1/2 seconds; 67 kv.p. For the oblique view the filter and distance were as above, but the kilovoltage was increased to 74 kv.p. These represent average technic, with the use of a Potter-Bucky diaphragm. When possible, "spot" films of the protruded disk should be made immediately after fluoroscopic demonstration of the disk.

The removal of the oil from the canal requires some ingenuity on the part of the fluoroscopist as well as the surgeon. The procedure is a bit tricky, but not difficult, as is shown by the fact that as the experience of the operators—surgeon and fluoroscopist—increases, the oil is removed more readily and more completely. In instances in which the spinal needle has been inserted into the L5 interspace (as for lesions suspected at L3 or L4), the feet are tilted downward until the lower part of the oil mass is pooled about the point of the needle (Fig. 3). The 5-c.c. Luer-Lok syringe is reattached, and the oil is aspirated by constant slow suction. As the oil comes into the syringe, the fluoroscopy table is tilted slowly (feet downward) and the oil is removed as one would empty a barrel through a spigot. When the needle is at the L3 or L4 interspace, the oil is placed with the needle at its center and the table tilted up or down as is necessary.

On removing the stylet from the needle preparatory to attaching the syringe for aspirating the oil, one can readily tell whether oil or spinal fluid will be obtained on aspiration. If oil surrounds the point of the needle, there will be no free flow of fluid, whereas if the oil has not been properly placed, spinal fluid will flow freely. In some instances, a moderate degree of patience and persistence is necessary for removal of all the oil. At times, removal can be facilitated by having the patient exhale with the closed glottis (Valsalva experiment) (7).

There is another procedure which is slightly easier, particularly if a spot-film device is used on a fluoroscopy screen. It avoids the possible danger of pressure by

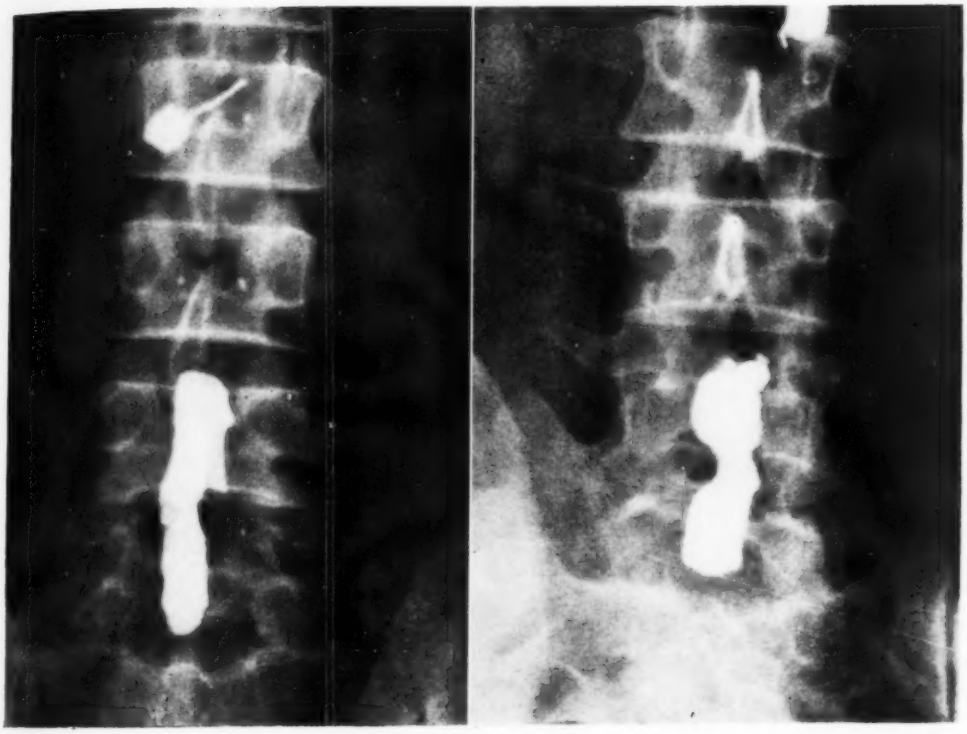


Fig. 4. True defects in pantopaque produced by a protruded disk.

the screen on the spinal needle and facilitates rapid filming as pantopaque flows through the spinal canal. L3 puncture technic is carried out with the patient on his side, which is usually easier than the prone position procedure. A spinal fluid specimen is taken and pantopaque is injected rapidly. The needle is withdrawn and the patient is then placed in the prone position and fluoroscopy and radiography are performed by the previously described or spot-film technic. The following factors are used in the spot-film fluoroscopy apparatus (Keleket): for fluoroscopy, 4 ma., 75 kv.p., 1 mm. Al on the large spot of the tube; for radiography 1/2 second exposure, 100 ma., 67 kv.p. (average), 1 mm. Al on the large spot of the fluoroscopy tube for the anterior-posterior view on a 5 × 7-inch cassette. If there is no L5 defect, an L5 tap is done with the patient on his side and he is carefully turned onto his abdomen. The foot of the fluoroscopy table is then tilted downward, the pantopqaue pools almost automatically around the needle point, and removal is easily accomplished. This procedure has the disadvantage of requiring two lumbar punctures and may be difficult or impossible in the presence of L5 defect or complete block above it. However, re-tap can be done in the original interspace and the usual pooling carried out with the aid of fluoroscopy.

When the technic of myelography is carried out carefully, the procedure is relatively painless; it can be completed in twenty to thirty minutes, and fairly accurate positive or negative objective evidence can be demonstrated (Fig. 4).

CLINICAL STUDY

The rigid training program instituted by the Armed Forces for the physical development of the men to endure the rigors of combat duty brings to light many cases of

Fig. 5. False positive disk, an artefact produced by the needle.

latent and manifest "low back pain." The more severe cases, incapacitating the patient for active duty, are usually referred to the Army general hospitals for definitive care and final disposition. At the time of this study there had been admitted to the Surgical Service of Bushnell General Hospital a total of 312 patients with "low back pain," with or without sciatic radiation. Most of the patients have been seen and treated conservatively (without operation) in the Section of Orthopedic Surgery; the remainder, in whom protruded intervertebral disks were suspected, were treated by the Section of Neurosurgery. Since the responsibility of the Army is limited to injuries incurred in line of duty, only those cases of questionable diagnosis, acquired in line of duty, and those cases requiring a more specific diagnosis than merely "low back pain with sciatica," for review before a disposition board, were subjected to special examination by pantopaque myelography. We have selected for this study the first 100 consecutive cases in which myelography was done.

In the group of 100 cases studied, 30 (30 per cent) showed definite myelographic evidence of a protruded disk. Thirty-seven patients were operated upon, including 5 with a false negative myelogram and 2 with a false positive defect. All the operated cases were in line of duty. Of the 30 patients with myelographic evidence of a true protruded disk, 3 (10 per cent) had multiple protrusions that were disclosed only by the aid of myelography.

Various studies have been made on the relationship of a narrowed intervertebral disk space to low back pain. Hodges and Peck (6) estimated that a narrowed disk space (lumbosacral joint) occurred in 57.2 per cent of 447 patients having low back pain with sciatic radiation. But no mention was made of verified protruded disks in this series. It was further pointed out by Hodges and Peck that "a narrow disk is undoubtedly to be expected in the case of patients showing evidence of bilateral or even unilateral fusion of the fifth lumbar vertebra with the sacral mass." Dandy (3) maintains that the diagnosis of a protruded disk can be made in over half the cases from x-ray examination of the lumbar spine alone. In view of these facts, we carefully reviewed the preoperative flat x-ray films of our 35 verified operated cases for evidence of a narrowed space at the level of the disk removed. In only 7 cases (20 per cent) did we find a definite narrowing that could be considered to be of diagnostic value—two L4 disks and five L5. With the preponderance of protruded disks occurring in the lower lumbar region, definite evidence of a narrowed disk space would be very helpful in establishing the diagnosis. But the normal variations that occur, particularly in the angle of the fifth lumbar with the first sacral body and the apparent "wedging" of the intervening disk, may be misleading (4, 13). We agree that different reports will vary (5) and that our series of 35 verified cases is too small to be of statistical importance.

In a careful study of the 100 myelograms,

18 cases were found to show a false defect on the film due to the presence of the needle in the canal, as pointed out earlier (4). Of these 18 cases, 2 early in the series were operated upon with negative findings, after which we awoke to the fact that the needle itself can produce a defect that closely simulates an extradural mass such as a protruded disk (Fig. 5). These we call "false positive disks." Conversely, in the series of 100 cases were 5 presenting the classical disk syndrome but showing a normal myelogram. These 5 patients were operated upon, and in each a protruded disk was successfully removed. Such cases, with negative myelographic evidence but positive clinical findings we call "false negative disks."

Total withdrawal of the pantopaque becomes easier with experience. In our hands it seems to be best accomplished when the spinal tap has been made at the L3-L4 interspace, which is usually above the protruded disk level (4). In 68 per cent of the cases the pantopaque (3 c.c.) was removed completely. In 14 per cent of the cases less than 0.5 c.c. of the oil was retained in the canal and could not be removed. In 15 per cent of the cases between 0.5 and 1.5 c.c. could not be withdrawn, due to globulation and scattering of the oil within the canal. In a few instances (3 cases) the oil was "caught" in the nerve root sleeves, making its removal impossible (Fig. 6).

That iodinated compounds cause a slight reaction in the intraspinal spaces has been reported both experimentally and clinically (1, 2). The fact that practically all the pantopaque was removed within a half hour after its injection in most of our cases (82 per cent) obviates much chance for a reaction. In 10 cases with retention of oil in amounts ranging from 0.1 to 2.0 c.c., lumbar punctures done at varying intervals (one to four days) after instillation of the pantopaque showed that reaction, when present, was not directly proportionate to the amount of oil retained. Seven of the 10 cases studied showed no reaction or alteration in the spinal fluid analysis. In the remaining 3 there were signs of a meningismus, with headache, generalized aching, and slight temperature elevation, that subsided in seventy-two hours. The case with the largest retained quantity of oil (2 c.c.), showed 172 cells and a total protein of 90 mg. in the spinal fluid. Another case, with a retention of 0.5 c.c., showed 126 cells but no elevation of total protein. The third case, with a residual of 0.25 c.c., showed 1,120 cells and a protein elevation of 110 mg. per cent. In all 3 of these cases lumbar puncture was done at twenty-four hours after myelography. All fluids were cultured and showed no growth of organisms. All patients made a rapid and uneventful recovery clinically and as shown by seventy-two-hour spinal fluid studies.

Fig. 6. Pantopaque spread into nerve root sleeves, with possibly some in the extradural space. No reaction or symptoms.

We have not had the opportunity to determine the possibility of absorption of pantopaque within the spinal canal, but the opinion has been expressed that the oil is absorbed at an estimated rate of 1 c.c. per year (6, 14). This fact should not

deter one from making every effort to remove all oil possible. We found evident reaction in only 3 of the 100 cases, but this is actually 9.4 per cent of the 32 cases in which some oil was retained. These 100 myelograms were done by 10 different officers with varying experience, and results became better as each individual's technic improved.

SUMMARY AND CONCLUSIONS

In a series of over 300 patients complaining of low back pain and sciatica, pantopaque was utilized as a contrast medium to aid in the diagnosis of 100 cases, which are here reported. We believe pantopaque to be the best substance for contrast myelography so far discovered. We feel it to be superior to lipiodol and air for myelography because of the ease of intraspinal instillation and of removal and because of its accuracy in delineating intraspinal lesions. It should be utilized as an aid in diagnosis but not as the final answer in all cases, particularly in the event of "false negatives."

Of the 100 cases reviewed, 30 showed a positive defect verified at operation. Thirty-seven patients were operated upon, with removal of a disk in 35. In 2 cases exploration failed to reveal any lesion, the "false positive" defect being due to the needle left in place at the time of myelography. In 5 cases in which myelography failed to demonstrate a protruded disk, one was removed at operation. Three patients (10 per cent of 30 positive myelograms) had multiple protruded disks, demonstrated only by the aid of myelography.

Pantopaque produced a reaction in 3 of the 100 cases, manifested by symptoms of meningismus and an elevation of the cell count and (in 2 instances) total protein in the spinal fluid. Rapid recovery followed without sequelae. Since the needle used for instillation in this technic is usually left in place as a matter of convenience, it has been pointed out that an artefact can be produced in the pantopaque column that may be erroneously interpreted as an extradural mass.

The verification of the presence of a protruded intervertebral disk or other suspected intraspinal lesion, as well as its accurate localization and the finding of an occasional additional unsuspected disk, makes the use of pantopaque in lumbar myelography advisable in indeterminate cases of low back pain with sciatica.

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Beneficial Effects of Roentgen Therapy in Advanced Cases of Rheumatoid Arthritis

Preliminary Report[1]

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ROENTGEN RAYS have been used for the treatment of joint diseases for many years. The earliest published report is that of Sokoloff (Russia) in 1897. Practically all types of joint involvement have been treated. There are reports of roentgen therapy in gonorrheal arthritis (Wetterer, Kaplan), in tuberculosis (Iselin, Jüngling), in gout (Albers-Schönberg), in osteo-arthritis (Staunig, Kahlmeter, Swaim, Goldhamer), and in hypertrophic spondylarthritis (Köhler, Kelly). Favorable results have been reported in all these conditions, but in the rheumatoid (atrophic, proliferative) types of arthritis roentgen therapy has been regarded as less satisfactory. Watt (England), in 1932, wrote: "In hypertrophic arthritis, radiation is the treatment of choice; in the atrophic type, little or no benefit can be expected." Smyth, Freyberg and Lampe, in this country, reported their results in rheumatoid arthritis as "so discouraging that we abandoned this treatment."

Favorable results have been obtained in Marie-Strümpell disease by Scott, Oppenheimer, Hare, Smyth, Freyberg and Peck, Rees and Murphy, and others. The term Marie-Strümpell disease, however, is used variously by different writers. There is an earlier stage in which the spine alone is affected and a later stage in which the hips, shoulders, and other peripheral joints are also involved. In all the reports on roentgen therapy of the disease, only the spinal manifestations are considered. This gives rise to the impression that there is a difference between the vertebral joints and the peripheral joints in rheumatoid arthritis in their response to x-rays. This has not been our experience. We have not found it a general rule that rheumatoid arthritis of the spine responds to roentgen therapy while rheumatoid arthritis of the peripheral joints does not. We have obtained beneficial results in rheumatoid arthritis, the response to radiation depending upon the stage of the disease and the dosage.

PRINCIPLES AND TECHNIC OF ROENTGEN THERAPY IN RHEUMATOID ARTHRITIS

Rheumatoid arthritis can be divided into three main stages, each of which must be differentiated from the others. The most valuable criterion of differentiation is the degree of impairment of mobility, which is easily determined clinically. In the *first stage*, pain and soft-tissue swelling restrict the active mobility of the joint, though passively it can be moved through its full range. In the *second stage*, mobility is restricted both actively and passively to a varying degree. In the *third stage*, no motion either active or passive is possible.

Roentgenographically, in the *first stage*, the joint space is of normal width; there may be an effusion or swelling of the periarticular tissues and some decalcification of the bones. In the *second stage*, there is usually a narrowing of the joint space, and sometimes destruction of the subchondral adjacent bone. In the *third stage*, the joint space may be obliterated, with an osseous

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ankylosis or a pronounced thinning of the articular cartilages associated with a fibrous ankylosis.

Pathologically, "in the early stages, the cartilage may appear nearly or quite normal, and the only visible change may be in the synovial membrane" (Nichols and Richardson). This is hyperemic and edematous, and an effusion is present, as well as periarticular soft-tissue swelling. The edematous phase is followed by signs of an inflammation of a more chronic nature. Fibrin is precipitated and tends to cause adhesions. The synovia becomes thickened because "almost from the beginning there is a constant increase in the number of fibroblasts" (Jordan). The lymphatics are obliterated (Kuhns), causing a retention of intra-articular fluid. This phase passes imperceptibly into that of hyperplastic change. "The synovial villi and the synovial lining cells proliferate" (Fisher). Thus, the *first stage* is characterized pathologically by a succession of edema, chronic inflammation, and hyperplasia of the synovial membrane.

The *second stage* is marked by the formation of granulomatous tissue, as described by Nichols and Richardson. This tissue is composed of lymphocytes and their derivatives. It fills the joint spaces with a pannus and then covers the articular cartilages, binding them together and eventually destroying them with the aggressiveness of a tumor. At the same time, the granulomatous tissue is gradually transformed into fibrous tissue, resembling, in this respect, a keloid, hyperplastic granulation tissue. It is the presence of the granulation tissue which gives rise to the designation "proliferative arthritis." Thus, the *second stage* is characterized pathologically by the presence of granulomatous and fibrous tissue.

The *third stage* is that of destruction of the cartilages and their replacement either by fibrotic strands or osteoid tissue, with complete ankylosis as the end-result. The joint space finally becomes obliterated. In the completely ankylosed joint granulation tissue may persist in the capsule, being responsible for the pain, spontaneously and on pressure.

Because of the pathological differences, the various stages of rheumatoid arthritis are of varying radiosensitivity. Different doses of radiation are required to influence an inflammatory edema, a chronic inflammation, a hyperplasia, and granulomatous tissue. The following depth doses have been found effective:

Inflammatory edema	50–100 r in 1 session.
Chronic inflammation	200–300 r in 1 to 3 sessions.
Hyperplasia	800–1,200 r in about 3 weeks.
Granulomatous tissue	1,200–1,600 r in about 3 weeks.

Since February 1942, these standards of dosage have been adhered to in treating rheumatoid arthritis in the Roentgen Department of the Goldwater Memorial Hospital. This is a municipal institution for the treatment of chronic diseases. There are no direct admissions to the hospital, but all patients are transfers from other hospitals in New York City or from the Welfare Island Dispensary. Our series of arthritic patients, therefore, had received practically all of the accepted methods of treatment prior to hospitalization in the Goldwater Memorial Hospital. Upon admission they were again subjected to a number of therapeutic procedures, such as gold therapy, physiotherapy (heat, massage, whirlpool), drugs, and orthopedic measures. Many had been treated with vaccines, and a few surgically. When all of these measures failed to produce or maintain a noteworthy result, the patients were referred for roentgen therapy. Thus, they represent selected material marked by the two following facts:

1. All of them had been suffering from their condition over a period of years.

2. All of them had undergone a variety of treatments which had failed to arrest the disease process.

All patients were in a more or less advanced stage of rheumatoid arthritis. Very few were in the first stage or showed symptoms of the inflammatory phases, though these developed in previously uninvolved joints during the stay in the hospital.

As a consequence, the majority of patients received dosages which ranged between 800 and 1,600 r. The dose was usually administered within a period of three weeks. In our experience this was the shortest period in which the treatments could be given to a joint without damage to the tissues. The factors used were 200 kv., 20 ma., 50 cm. distance, 0.5 mm. Cu + 1.0 mm. Al filtration, with a half-value layer of 0.9 mm. Al. The size of the port depended upon the area treated. Each port was treated three times a week, and the amount delivered daily depended upon the part, the area, and the size of the port. Some joints were treated through two and others through three ports at each session. Most cases received their full course of treatment in eight sessions to any one joint. Where multiple joints required treatment, two joints were treated alternately, so that the patient actually received treatment daily, except on Sundays and holidays. If all joints were affected, the body was divided into fifteen different treatment areas as follows:

	Number of Areas
Fingers of both hands and wrists	1
Elbows	2
Shoulders	2
Toes	1
Ankles	1
Knees	1
Hips	2
Lumbosacral spine	1
Dorsal spine	1
Cervical spine	1
Temporomandibular joints	2
TOTAL	15

Bilateral affected parts that could be treated simultaneously were considered as one area. When two corresponding joints differed considerably in the stage of disease, they were treated separately.

It was calculated that the treatment of all areas according to our method would require a period of about twenty-four weeks. This is not recommended. Most of our patients received therapy to six areas only during any one course of treatment.

To date we have treated 66 cases. Of this group we have selected 10 for critical study, as shown in Table I. These patients had the disease for at least two years prior to roentgen therapy and had been subjected to the usually accepted types of therapy for rheumatoid arthritis. Some of the spinal joints as well as the peripheral joints were involved. Radiation was given as indicated above. At least two years have elapsed since the roentgen treatment was completed. The number of the joint areas treated in these 10 patients totals 85.

RESULTS OF TREATMENT

Beneficial results have been obtained with roentgen therapy in a number of patients suffering from rheumatoid arthritis. Some who were incapacitated by the disease and hospitalized for a number of years improved to such an extent that they were discharged from the hospital and were able to resume either all or some of their previous activities. Some discarded their crutches and canes and were able to walk without assistance. Pain and muscle spasm diminished in some and disappeared in others. Many patients who could not raise their arms to shave or comb their hair, who could not bend to tie their shoes, who could not sleep, and breathed only with difficulty because of pain, obtained increased mobility of the spine and extremities and relief from suffering. Their posture and gait improved. Because of these results in cases previously treated by numerous methods without success, we feel that the use of roentgen therapy is justified in certain cases of advanced rheumatoid arthritis.

The therapeutic results depend upon the action of the roentgen rays on the joint lesion and the periarticular tissues. We be-

TABLE I: ANALYSIS OF TEN CASES OF ARTHRITIS RECEIVING ROENTGEN THERAPY

Case	Age and Sex	Duration of Illness in Years	Previous Therapy	Roentgen Therapy			Result of Roentgen Therapy
				Joints Involved	Stage	No. of Roentgens in Air	
1. A. D.	29M	9	*Medical* Gold therapy (2 courses); numerous other drugs *Orthopedic* None *Physical* Heat; massage; exercises; whirlpool	Temporomandibulars Elbows Wrists Hips Knees Ankles Cervical spine Dorsal spine Sacro-iliacs	2 1 1 3 3 3 3 3 3	1,800 each 2,400 each 1,800 each 3,200 each 3,200 each 2,400 each 1,200 2,400 2,000	Pain decreased in all joint areas treated. Temporomandibular articulations free of pain and mobility returned to normal
2. M. W.	22M	7	*Medical* Gold and other drugs *Orthopedic* Vitellium cup arthroplasty, left hip *Physical* Heat; massage; exercises; whirlpool	Shoulders Hips Knees Cervical spine Lumbar spine Sacro-iliacs	1 3 2 3 3 3	2,400 each 3,800 each 3,200 each 1,200 2,200 2,200	Pain diminished. Improved mobility of cervical spine and knees. Mobility of shoulders returned to normal
3. J. G.	26M	14	*Medical* Sulfa drugs; autogenous and typhoid vaccines *Orthopedic* Traction and body cast *Physical* Heat; masage; exercises; whirlpool	Right hip Cervical spine Dorsal spine Sacro-iliacs	1 2 2 3	2,400 3,200 3,200 1,600	Pain decreased in areas treated. Mobility of right hip returned to normal. Resumed former occupation
4. F. W.	28M	14	*Medical* Gold; sulfa drugs; typhoid vaccines *Orthopedic* Cast for neck and body; crutches *Physical* Heat; massage; exercises; whirlpool	Shoulders Hips Right knee Left knee Ankles Feet Cervical spine Dorsal spine Sacro-iliacs	1 2 2 1 1 1 1 2 3	2,000 each 3,200 each 3,200 800 2,400 each 1,800 each 2,400 3,200 3,000	Pain decreased in areas treated. Mobility improved in most of the joints. Discarded crutches. Resumed former occupation
5. H. H.	35M	10	*Medical* Gold (2 courses); vitamin B; bee venom; aspirin daily *Orthopedic* Casts for knees *Physical* Heat; massage; exercises; whirlpool	Right shoulder Left shoulder Hips Knees Right hand Left hand	3 2 3 3 2 3	3,200 2,800 4,800 each 4,200 each 1,600 2,400	Pain decreased in areas treated. Increased mobility in some of the fingers
6. N. G.	31M	4	*Medical* Gold; ertron; hormones *Orthopedic* Spine brace and sacro-iliac belt *Physical* Heat; massage; exercises; whirlpool	Hips Cervical spine Dorsal spine Lumbar spine Sacro-iliacs	1 1 2 2 3	2,400 each 1,600 2,400 1,200 1,200	Pain decreased in areas treated. Chest expansion increased 1½ inches. Resumed former occupation

lieve that two factors determine the outcome: the stage of the disease, and the dose delivered.

Decrease of pain and increase of motion are the two beneficial effects, but they are not invariably associated. The relationship between the two varies considerably in different joints. The duration of the disease, although of significance, has not proved of great importance. Some joints apparently deteriorate rapidly, others slowly. The stage of the disease in the joint under treatment is the essential factor.

The best results were obtained in *stage one* lesions, where active but not passive

TABLE I: ANALYSIS OF TEN CASES OF ARTHRITIS RECEIVING ROENTGEN THERAPY.—*Continued*

Case	Age and Sex	Duration of Illness in Years	Previous Therapy	Roentgen Therapy			Result of Roentgen Therapy
				Joints Involved	Stage	No. of Roentgens in Air	
7. E. L.	26F	7	*Medical* Gold and other drugs *Orthopedic* None *Physical* Heat; massage; exercises; whirlpool	Shoulders Elbows Wrists Hands Hips Cervical spine Lumbar spine Sacro-iliacs	2 2 2 1–3 1 2 3 3	3,600 each 3,200 each 3,200 each 2,600 each 3,200 2,000 2,400 2,400	Pain decreased in areas treated. Mobility increased in some. Works as a counter girl at a news stand
8. I. C.	23F	2	*Medical* Gold; typhoid vaccine; vitamins B and D *Orthopedic* None *Physical* Heat; massage; exercises; whirlpool	Elbows Hips Knees Ankles Cervical spine	2 1 1 1 2	3,200 each 1,500 each 3,200 each 1,800 each 3,200	Pain decreased in areas treated. Mobility increased. After 4 months, recurrence in a few of the treated areas, and progression in some of the non-treated areas
9. M. E.	37F	11	*Medical* Gold; fever therapy; many drugs *Orthopedic* Casts on both lower extremities *Physical* Heat; massage; exercises; whirlpool	Shoulders Elbows Knees Ankles Lumbar spine	2–3 2–3 2–3 2–3 2	3,200 each 3,200 each 4,800 each 1,800 each 1,200	Pain decreased for a few months; then returned
10. M. L.	45F	6	*Medica* Cobra venom; aspirin daily *Orthopedic* Neck cast; tenotomy of flexors of knees *Physical* Heat; massage; exercises; whirlpool	Right shoulder Hips Knees Hands Cervical spine Lumbar spine	3 2 2 1 2 2	3,200 4,800 each 2,400 each 1,200 each 2,400 2,400	Pain decreased in areas treated. Walking improved. Pain returned to spine after 2 months, and to right shoulder after 4 months

motion is limited. Here mobility is restricted because of spasm due to pain caused by the pathological process within the joint. With the elimination of pain, active mobility returned to normal. With relief of pain in *stage two*, increased mobility is in direct proportion to the amount of spasm and destruction within the joint. The increased active mobility is comparable to the extent of passive mobility. Another factor which plays a part is the transformation of granulomatous tissue into scar tissue within the joint. In *stage three*, because of the ankylosis, either fibrous or osseous, there is no return of mobility even with relief of pain.

Another beneficial effect is a decrease of the swelling; and on one occasion we observed a reparative process at the site of a destructive bone lesion.

COMMENT

It appears that doses varying considerably in amount are required to obtain comparable effects in joints in different stages of the disease process, even in the same individual. If, of the interphalangeal joints of three neighboring fingers one is in the first stage, another in the second stage, and the third in the third stage, a given dose of x-rays may be highly effective in the first, slightly effective in the second, and not at all effective in the third. The same holds true for different parts of the spine, depending upon the stage of the disease process. A given dose producing a favorable result in the cervical spine may be only moderately effective in the dorsal spine and fail to produce any effect in the lumbar spine, if the cervical spine is movable, the

dorsal spine moderately restricted in its motion, and the lumbar spine is ankylosed.

To obtain a comparable effect, larger doses of x-rays are required in the more advanced stages. The difference in dosage may be as much as 100 per cent. If 800 r eliminates pain in the first stage, 1,200 r may be necessary for the second stage, and 1,600 r for the third, in order to obtain comparable results. This is due to the fact that the pain in the three stages is due to different causes. Pain may be produced by edema in the early stages, by granulomatous tissue in later stages, and by scar tissue in the final stages. The effectiveness of roentgen rays depends upon the sensitivity of the tissues irradiated, which, in turn, depends upon their anatomical structure and biological activity. Dilatation of capillaries followed by increased resorption of inflammatory products can be obtained by a smaller dose than is necessary to cause regression of granulomatous tissue.

Granulomatous tissue requires different doses in its various stages. The earlier the stage in which it is treated, the smaller is the dose of x-rays required either to destroy or arrest its growth. In this respect, there is a far-reaching analogy between the radiation effect on the granulomatous tissue in rheumatoid arthritis, in Hodgkin's disease, in keloids, and benign giant-cell tumors. There is a similarity in the cellular composition of these tissues and, accordingly, in their response to roentgen rays.

We have treated a number of patients in part with smaller doses, and others with larger doses than indicated above. The small doses were found to be either not effective at all or for less than a year, often for only a few weeks or a few months. We have concluded that a joint in a late stage of rheumatoid arthritis should not be considered as adequately treated if the dose delivered to the lesion is less than 1,600 r within a period of four weeks. Larger doses, or the same dose delivered in less than two weeks, are apt to produce undesirable reactions, to be discussed later.

It is not unlikely that in the future it may be found necessary to increase or decrease the dosages given in this series. When the significance of the time factor in the roentgen treatment of rheumatoid arthritis is better understood, it may be found that the dose given in a single session should be larger and the intervals between single applications should be either decreased or increased, and the total dosage changed accordingly.

Radiation in effective dosages in the advanced stages of rheumatoid arthritis can produce undesirable effects in both the skin and the blood-forming tissues.

The largest depth dose delivered to a joint was 1,600 r in three to four weeks. This is only a fraction of the dose applied in cancer, which may require between 3,500 and 5,000 r to the tumor area in an equal period of time. In our experience skin reactions of undue intensity or of a permanent character occurred in a few cases in which a second course of irradiation was given before the skin had had time to recover from the first series. We believe that a second course of x-ray therapy should not be instituted in less than one year to a joint area which has previously received a dose of 1,600 r. Heavier filtration should be used during the second course.

When a single course of irradiation is given, as was the case with most of our patients, any skin reaction of undue intensity or of a permanent character can be avoided when the general rules concerning the application of roentgen rays are observed. In the majority of cases, erythema, pigmentation, and sometimes desquamation, varying in intensity according to the dose, are the only skin reactions encountered. All of these are of a temporary nature and none requires specific treatment.

Since the white and red blood cells are in part produced by different tissues, it is necessary to consider them separately in assessing the effects of radiation.

The lymphocytes are produced in the lymph nodes, which are present throughout the body. Consequently they are irradiated whenever any part of the body is

treated with roentgen rays. In the treatment of arthritis, however, the irradiation is limited to a single area, or at most to two areas at the same time, so that the effect of the rays is confined to a small group of nodes and remains, therefore, clinically unnoticed. Only with exposure of a large part of the body, or multiple areas, may a drop in the number of lymphocytes be found.

Since the red blood cells and certain of the leukocytes in adults are formed by the red marrow, a drop in their number can be expected when the hips, shoulders, intervertebral, or costovertebral joints are irradiated. From experience with roentgen therapy of cancer metastases we know that heavy irradiation of the vertebral column does not produce noteworthy changes in the blood picture when a part of the spine only is treated. It appears, therefore, that when the entire spinal column is affected by rheumatoid arthritis, as not infrequently happens, only one part should be treated at a time, and a period of rest should be given before the treatment of the next area is begun. When the spinal and the peripheral joints are affected, they should be treated alternately. Furthermore, the fields including the intervertebral or costovertebral joints may be long but should be narrow, to exclude as much of the ribs as possible from the field of irradiation.

It should be borne in mind that rheumatoid arthritis tends of itself to produce an anemia. This may be slight, or may assume larger proportions, in which case "it becomes more than a symptom and constitutes a complication" (Pemberton). An anemia may be induced, or an existing anemia aggravated, and the white count depressed, if treatment to multiple joint areas is too active and without interruption. When the blood count discloses an advanced stage of anemia, a blood transfusion should be given prior to or during the course of roentgen therapy. No drug with toxic effects, such as the sulfa drugs or gold preparations, should be given coincidentally with irradiation. When roentgen therapy has a beneficial effect on the disease process, the anemia improves and there is an associated decrease of the sedimentation rate.

Radiation therapy is a local and not a constitutional form of treatment and can be given to only one or a few joints at the same time. Since rheumatoid arthritis is a polyarthritic condition, it is obvious that agents which affect simultaneously all joints involved, such as gold, vitamins, or baths, are superior to x-rays. Therefore, roentgen therapy should never be applied as a primary method in rheumatoid arthritis, but should be reserved for cases which fail to respond to other therapeutic measures. Roentgen irradiation should be supplemented by physiotherapy, particularly exercises and massage.

Patients in generally poor health, with a progressive anemia, with advanced atrophy of the muscles, should not be subjected to x-ray therapy.

SUMMARY

During the past two years we have treated 66 patients with advanced rheumatoid arthritis, patients who failed to respond to the usually accepted methods of treatment such as gold therapy, vaccines, physiotherapy, surgery, etc. These patients were treated according to their pathological status as determined by clinical and roentgen examinations. The involvement was classified as stage one, two, or three, and the amount of radiation delivered depended upon the stage of the disease process within any given area. Of this group we selected for critical study 10 patients, with a total of 85 joint areas involved. Good results were obtained in most cases. Roentgen therapy is given for the relief of local symptoms, to alleviate pain, and increase mobility, and is employed only after failure of the usually accepted methods of treatment.

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Solitary Myeloma: Review of Sixty-one Cases[1]

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THE TREATMENT and prognosis of multiple myeloma are usually regarded as extremely discouraging. In recent years, however, numerous reports have appeared of solitary myeloma and in many of these cases x-ray therapy, judiciously carried out, delayed the progress of the disease, produced relief of symptoms, and prolonged life.

Among 24 cases of myeloma seen in the University of Chicago Clinics, 2 examples of solitary lesions have been observed, both of which responded excellently to x-ray therapy.

CASE REPORTS

CASE I: T. O., a machinist aged 48 years, was seen on May 14, 1941, complaining of persistent pain in the right hip, following an injury six months previously. The pain was dull, aching in nature, more severe on exercise, and accompanied by a slight limp. The history was otherwise irrelevant.

The patient was well nourished and robust, with tenderness in the right hip on all extremes of motion but no other abnormal physical findings. The red blood cell count was 4,700,000; hemoglobin 13.0 gm.; white cell count 8,000. The specific gravity of the urine was 1.028; it contained no albumin or sugar, no casts or red blood cells. No test was made initially for Bence-Jones protein. The Wassermann reaction was negative.

X-ray examination of the right hip disclosed a large multiloculated expansile lesion of reduced density involving the greater portion of the ilium adjacent to the acetabulum and of the ischium (Fig. 1). The margins of the lesion were sharply defined and the overlying cortex was irregularly thinned.

On May 21, 1941, a biopsy was performed. In the region about the spine of the ischium along the posterior wall, the bone was eroded by a soft, grayish-red tissue. This was curetted out. Microscopic examination showed densely packed round cells with dark, round, eccentrically placed nuclei at the periphery of which chromatin was distributed in cart-wheel pattern. A diagnosis of plasma-cell myeloma was made. The urine was then tested for the presence of Bence-Jones protein and none was found. Plasma proteins were 7.04 gm. per cent with A/G = 3.85/3.19 = 1.20.

Fig. 1. Case I. Multiloculated lesion of right ilium adjacent to the acetabulum and of the ischium.

On June 7, 1941, x-ray therapy was begun. The patient received treatments of 300 r in air to each of three portals at 200 kv., 20 ma. A total of 2,500 r to each of three portals was given in three weeks. Following these treatments the patient experienced marked relief of pain and subsequently returned to work.

On Sept. 12, 1941, the patient was again seen, complaining of occasional pain in the right hip. The x-ray appearance of the lesion was unchanged. A second series of roentgen treatments was then given, for a total dose of 2,500 r to each of three portals.

From that time until Jan. 30, 1945, four years and three months after the onset of symptoms, there had been no progression of the disease as seen by x-ray examination. The only noteworthy change was progressive collapse and flattening of the head of the right femur due to necrosis produced by the radiation. Roentgenograms of the rest of the skeleton and the chest (Sept. 6, 1944) were negative. The patient still had some pain and difficulty in walking but had been able to continue with his work. A total depth dose of 5,200 r had been given.

[1] From the Department of Surgery, The University of Chicago. Accepted for publication in January 1945.

Fig. 2. Case II. Lesion of right ilium adjacent to the sacroiliac joint and extending along the crest.

CASE II: S. T., male aged 68 years, a physician, was admitted on Dec. 13, 1937, with pain in the right hip of four months' duration, gradually increasing in severity. The pain was dull and aching in nature. Except for the presence of diabetes mellitus, controlled by diet, the history was irrelevant.

The patient was well nourished and well developed, walking with an obvious limp. His general condition was unimpaired. A large mass was palpated in the right ilium, extending from the sacroiliac joint to the anterior portion of the bone. There was pain in the region of the right sacroiliac joint upon abduction and rotation of the right leg. The red blood cell count was 4,240,000; hemoglobin 8.52 gm., white cell count 6,900. The specific gravity of the urine was 1.024. It contained no albumin, no sugar, no red blood cells or casts. The Wassermann reaction was negative.

X-ray examination disclosed a large area of reduced density in the upper portion of the right ilium adjacent to the sacroiliac joint and extending along the crest as far as the anterior superior spine (Fig. 2). Coarse trabeculae of increased density were present within the lesion.

On Dec. 15, 1937, a biopsy was performed. At the crest of the ilium a dark reddish-brown mass had extensively eroded the bone. Microscopic examination disclosed large, closely packed oval cells with cartwheel granules and eccentric nuclei. The diagnosis of plasma-cell myeloma of the ilium was made. The urine was negative for Bence-Jones protein.

Previous to admission, the patient had received x-ray therapy, 1,500 r in air having been given to the right pelvis through each of two portals, totaling 3,000 r. Treatment was continued with doses of 300 r to each of two portals (220 kv., 50 cm. distance, Thoraeus No. 1 filter). In June 1938, ten months after the onset of symptoms, a total of 13,000 r had been given. At this time the patient's condition was excellent, x-ray examination showed no further extension of the lesion, and some recalcification had taken place at the margins.

The patient was again seen on Nov. 18, 1938, at which time the pain had increased somewhat. The lesion appeared unchanged. X-ray therapy was continued. The condition then remained unchanged until Nov. 21, 1941, when the patient was found to have a carcinoma of the prostate, from which he died in July 1942. He had lived four years and eleven months from the onset of symptoms referable to the myeloma, during which time over 28,000 r had been applied to the right hip. At no time was generalization found.

These cases, together with 59 similar cases of solitary myeloma collected from the literature, were studied with regard to the duration of life, the effects of x-ray treatment, and the course of the disease as compared to that of multiple myeloma. The diagnosis in all of these cases had been confirmed by biopsy and histologic examination. Geschickter and Copeland in 1931 collected 5 cases reported up to that time. In 1936 Cutler, Buschke, and Cantril reviewed 18 cases collected from various sources. Paul and Pohle in 1940 submitted a series of cases collected from the literature, including 5 coming under their personal observation. Additional examples have been reported by King, Abel, Toth and Wintermantel, Coley, Bichel and Kirketerp, Willis, Esposito, and Batts.

CLINICAL OBSERVATIONS

The average age of the 61 patients in this series was fifty years. Only two were under thirty; one was seventy-one. The distribution by decades was as follows:

Below 30 years	2 (3%)
30 to 40 years	10 (16%)
40 to 50 years	12 (19%)
50 to 60 years	26 (44%)
60 to 70 years	10 (16%)
Over 70 years	1 (2%)

Forty-one patients, or 68 per cent, were males; 20, or 32 per cent, females. The same high incidence in males and predominance in the fifty-to-sixty-year age group is characteristic of multiple myeloma. Batts reported 40 cases of multiple myeloma, of which 63 per cent were in males. Similarly, Geschickter and Copeland recorded a series of cases of multiple myeloma with the peak of incidence at fifty-five years, with 70 per cent of the patients males.

The most frequent site of involvement is the ilium, followed by the femur, humerus, and thoracic vertebrae. The figures for the series are as follows:

Site	No. of Cases
Ilium	13
Femur	9
Humerus	9
Thoracic vertebrae	9
Skull	5
Cervical vertebrae	4
Lumbar vertebrae	3
Maxilla	3
Clavicle	1
Scapula	1
Sternum	1
Tibia	1
Pubis	1
Sacrum	1
TOTAL	61

It is of interest that the ribs, which are a frequent site of multiple myeloma, were not involved initially.

In 41 cases tests were made for Bence-Jones protein in the urine. In only 4 instances was it found early in the course of the disease. It appeared as a late manifestation in 9 cases, in 7 of which generalized spread of the lesions had occurred. The small number of early cases showing Bence-Jones protein—4 out of 41, or 10 per cent—is in contrast to the usual finding in multiple myeloma. Batts reported Bence-Jones protein present in 50 per cent of 40 cases, while Geschickter and Copeland reported its presence in 65 per cent of their collected series of multiple myeloma.

Clinically the outstanding complaint on first admission is of pain. This is usually fairly well localized to the area of the lesion, aching in nature, chronic, and gradually increasing in severity. A mass may be palpable and tender. Pathological fracture is frequent, especially following exertion, a fall, or undue stress and strain. The patient frequently gives a history of injury or of a fall months previously.

The generalized weakness and anemia of multiple myeloma are rarely found in these cases. Hyperproteinemia and renal damage with accompanying nitrogen retention, low blood pressure, albuminuria, and urinary casts, seen so commonly in multiple myeloma, are seldom encountered in cases of solitary myeloma.

ROENTGEN APPEARANCE

The roentgenologic appearance is of great importance in the diagnosis of solitary myeloma. Differentiation from other similarly destructive lesions of bone may be difficult, and biopsy should be done in all cases.

Two types of lesions have been described roentgenologically. The first type is cystic and trabeculated, closely resembling giant-cell tumor. The lesion is large, of reduced density, and sharply limited, and within it are thickened irregular trabeculae. It is usually found in the pelvis or long bones, in the medullary portion of the bone, frequently expanding the cortex. Pathological fracture is often present. The second type of lesion as observed roentgenologically is purely destructive, very similar in appearance to an osteolytic cancer metastasis. It is sharply demarcated, homogeneously rarefied in appearance, and seldom shows expansion. The vertebrae are frequently involved. The histologic appearance of the two types of lesion is the same.

Solitary myelomas are frequently confused with giant-cell tumors. In this connection Paul and Pohle say: "Given a cystic trabeculated lesion, expansile in character . . . . in an atypical place for giant-cell tumor, myeloma should be considered." Other lesions entering into the differential diagnosis are solitary bone cyst, carcinoma metastasis, and osteolytic types of sarcoma.

PATHOLOGY

In 57 of the cases of this series the histologic diagnosis was plasma-cell myeloma; the cell type was not stated in the remaining 4 cases. The typical pathological picture is that of densely packed, large irregular cells, round or oval, measuring 9 to 11 μ. There is little evidence of stroma. The nuclei are eccentrically placed, dark-staining, with chromatin granules in cart-wheel pattern at the periphery.

TREATMENT

Various forms of surgery and irradiation, either alone or combined, have been used. Irradiation has been given in the form of deep x-ray therapy, surface radium, interstitial radium, or radon seeds. Surgical procedures have included curettage, partial resection, complete resection, and amputation.

Forty-three cases were treated by irradiation following biopsy or curettage. In many cases irradiation was continued over several years. The dosage varied with different authors but treatments were usually given in fractions of from 200 to 500 r to each of two or more portals in courses totaling 1,000 to 3,000 r. By preserving skin surfaces and using as many portals as feasible, it is possible to give large total doses.

Batts, treating a myeloma involving the ilium, used an initial dose of 300 r in air delivered through each of three 20 × 20-cm. portals. This relieved pain and the patient was able to resume walking. Subsequent treatments were given once a month for five months, with 200 r in air per portal. One year later this series was repeated. At that time there was evidence of generalization and treatments were given to dorsal and lumbar vertebrae, ribs, and femur in the same manner. They were carried out at varying intervals for the following eight years with continued relief of pain. The patient lived over fourteen years from the onset of symptoms and over nine years after treatment was begun.

Esposito treated a myeloma of the frontal bone with 4,100 r in air over a period of sixteen days. Toth and Wintermantel gave their patient 1,700 r/skin through each of three portals in a total of fifteen sessions. Remission of pain was noted. Four months later the treatments were repeated and improvement continued.

In the case reported by Pohle and Stovall and later reviewed by Paul and Pohle, deep x-ray therapy was given in repeated doses of 200 r to each of two portals. Subsequently, as the condition became generalized, "general body exposure" was employed, 25 r being administered to each of four fields to include the entire body surface. Paul and Pohle report good results with the latter technic in some instances.

The two cases reported in the present paper were treated with 300 r in air to two or more portals with a total dosage of 2,500 r per portal for each course. This was repeated in one patient several times, and marked symptomatic improvement was obtained.

EFFECTS OF TREATMENT

It is instructive to compare the duration of life in treated cases of solitary myeloma with that in multiple myeloma. Geschickter and Copeland give the average duration of multiple myeloma as two years. Batts found the average duration from the onset of symptoms until death to be two and one-half years.

Of the 43 patients with solitary myeloma in our collected series treated by irradiation following biopsy or curettage, 27 were alive at the time of the report and 16 were dead. One death occurred shortly after operation from cardiac failure; of the remaining 15 who had died, all but one lived over two and one-half years from the onset of symptoms. The average duration of life from the onset of symptoms was seven years. Eight patients lived over five years. Twelve of the 15 patients lived over two years from the original admission, 9 of these over three years, and 5 over four years. The average duration of life from the time of the original admission was three years and nine months as compared to the aforementioned figure of fourteen months for multiple myeloma (see Table

TABLE I: DURATION OF LIFE IN 43 CASES OF SOLITARY MYELOMA TREATED BY IRRADIATION

	1 yr.	2 yr.	3–5 yr.	5–7 yr.	7–9 yr.	Over 9 yr.
Sixteen patients dead at time of report*						
Duration from onset of symptoms: average 7 yr.						
No. living *to* each period	..	2	5	4	1	3
No. living *in* each period	15	15	13	8	4	3
Duration from first admission; average 3 yr. 9 mo.						
No. living *to* each period	1	3	6	1	1	1
No. living *in* each period	13	12	9	3	2	1
Twenty-seven patients living at time of report						
Duration from onset of symptoms: average 3 yr. 8 mo.						
No. living *to* each period	6	4	2	6	3	1
No. living *in* each period	22	16	12	10	4	1
Duration from first admission: average 3 yr.						
No. living *to* each period	6	2	4	4	2	1
No. living *in* each period	19	13	11	7	3	1

* One death postoperatively from cardiac failure.

I). The true average may be still higher, as only 9 of the patients died of generalization; the remaining 7 succumbed to other causes.

Of the 27 patients who were living at the time of report, many had not been observed long enough to warrant definite conclusions as to duration of life. Twenty-two, however, were alive over one year from the onset of symptoms; 16 were alive over two years. Nineteen of the 27 patients were alive over one year after admission and, of this number, 13 were alive over two years.

Of the 43 patients treated by irradiation—discounting the one postoperative death—all but 2 obtained relief of pain and many returned to normal activity. In 29 cases recalcification of the lesion demonstrable by x-ray was reported.

Generalized spread took place in 14 of the 43 cases and accounted for 9 of the 16 deaths, the average time elapsing between admission and generalization being twenty-one months. Of the 9 patients dying from generalization, 5 lived over two years with multiple foci which were treated by irradiation. Five patients were living with generalized lesions at the time the cases were reported.

There can be little doubt of the value of x-ray therapy in the treatment of solitary myeloma. Though irradiation assuredly does not cure the disease, persistent and intensive treatment of the original lesion and of recurrences definitely delays generalization and, even when this has occurred, produces symptomatic relief. Needless to say, such a program of treatment necessitates frequent x-ray examination in order that recurrences and new foci be detected early.

RELATION OF SOLITARY MYELOMA TO MULTIPLE MYELOMA

Cutler *et al.* are of the opinion that there are two types of solitary myeloma, one type in which the lesion is solitary in the beginning and later becomes generalized and a second type in which the lesion is completely benign in nature, remaining localized throughout its entire course.

As suggested by Paul and Pohle, the evidence appears to indicate that myeloma may show varying degrees of malignancy from the rapidly progressing multiple form to the solitary lesion which may remain localized for as long as eight or ten years without generalization. Such solitary myelomas may be considered to be at the "benign" end of a gradient, while the widely spreading, rapidly fatal multiple form is at the opposite "highly malignant" end. Between these two extremes there will be found intermediate types, such as multiple myelomas of longer duration and solitary myelomas of more rapid spread and less radiosensitivity. The wide variation

in the duration of the disease, in the time elapsing before generalization, and in the radiosensitivity of both multiple and solitary myelomas strongly suggest such an explanation.

It is possible, as Paul and Pohle state, that cases of multiple myeloma with symptoms of long duration, if seen early enough, would present a solitary lesion which would respond well to x-ray therapy. In many instances it appears reasonable to suggest that the multiple form of myeloma is multiple at the time of first observation because spread occurred early from a primary focus and only with generalization did the typical appearance of multiple myeloma become manifest.

The evidence indicates that the cyst-like trabeculated lesion seen by x-ray is more benign and more amenable to roentgen therapy, and that in those cases where generalization occurs early the more osteolytic type of lesion is predominant.

As to the nature of myeloma, whether its etiology be that of a blood dyscrasia or a true neoplasm, the evidence from these cases is not conclusive. The type of generalization is suggestive of true neoplasia, yet Bichel and Kirketerp in two reported cases of solitary myeloma found a high proportion of plasma cells by sternal puncture.

SUMMARY AND CONCLUSIONS

1. Fifty-nine cases of solitary myeloma are reviewed and 2 new cases added. In every instance the diagnosis was confirmed by biopsy.

2. The x-ray appearance is of two main types. One type appears as a cystic, trabeculated lesion closely resembling giant-cell tumor. The second is a frankly osteolytic lesion closely resembling metastatic carcinoma.

3. The incidence of the disease was highest in the fifty-to-sixty-year age group, in which 26 cases, or 44 per cent, were found. Males were predominantly affected, accounting for 41 cases, or 68 per cent. The ilium, femur, humerus, and thoracic vertebrae were the sites most frequently involved. Bence-Jones protein was found initially in only 10 per cent of the 41 cases tested.

4. X-ray therapy following biopsy or curettage was carried out in 43 cases and appears to be the treatment of choice. It gave relief of pain and prolonged life several years beyond the average for multiple myeloma.

5. The average duration of life in the treated cases followed until death was seven years from the onset of symptoms and three years and a half from the original admission.

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Volvulus of Megacolon Reduced During Barium Enema Examination[1]

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VOLVULUS of a megacolon probably occurs more frequently than is generally appreciated. Weeks (1) reported an example and reviewed some 63 cases which he gathered from the literature. Half of these patients had previously experienced attacks of obstipation, abdominal pain, and distention. It is not unreasonable to assume that volvulus, either partial or complete, occurs not infrequently in patients with megacolon and can be reduced before strangulation or necrosis ensues. Report of a case of megacolon complicated by volvulus in the sigmoid region and reduced during barium enema examination follows:

CASE REPORT

A. M., a white male aged 39, entered Mount Sinai Hospital on Jan. 12, 1944, complaining of abdominal cramps which had been increasing in severity for two weeks prior to entrance. The patient stated that he was "normally constipated," but that constipation had been more troublesome in the past two months. Only mucus and very little fecal matter, the latter in the form of small hard nodules, were passed at intervals of several days. No blood was observed in the stool, but tenesmus was present. The abdomen had become increasingly distended during the last few months. The appetite was fairly good but the patient complained of some nausea several days before entering the hospital. The family history was essentially negative.

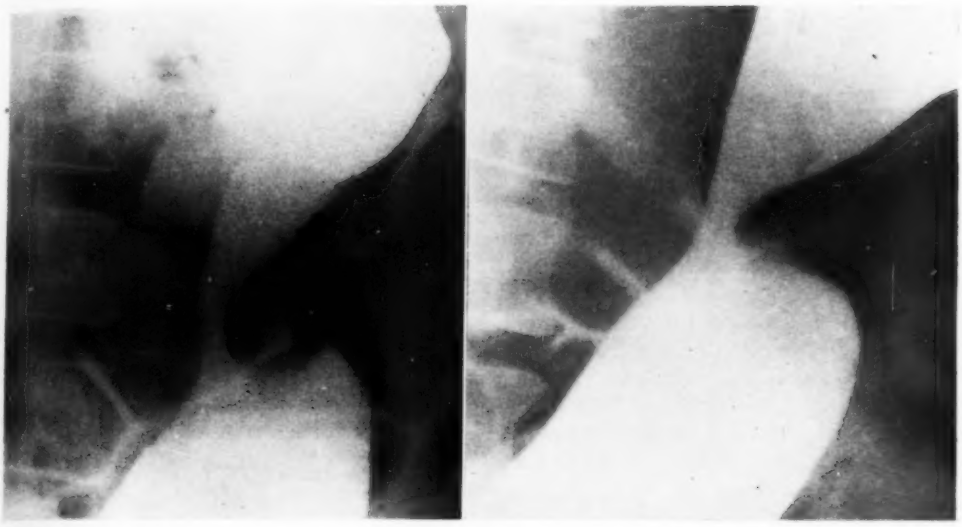
The patient was well developed and well nourished, and subacutely ill. The temperature was 98° F., pulse 104, respirations 20, blood pressure 124/76. Examination of the head, neck, and chest was essentially negative. The abdomen was moderately distended and tympanitic throughout. No masses were palpable and no definite abdominal tenderness was present. The bowel sounds were diminished in intensity but slightly increased in number. The clinical impression was "acute mechanical obstruction of the distal colon, cause undetermined but carcinoma to be excluded."

Blood determinations on admission to the hospital showed 14.5 gm. of hemoglobin and a white cell count of 7,850, the differential count being normal. Urinalysis was essentially negative; only a few leukocytes were demonstrated per high power field. The blood Kline test was negative.

Fig. 1. Anteroposterior roentgenogram of abdomen taken on day of admission, Jan. 12, 1944, showing distention of the large intestine down to about the sigmoid colon. Roentgen appearance consistent with diagnosis of mechanical intestinal obstruction.

Roentgen examination of the abdomen in the recumbent and upright positions on the day of admission to the hospital showed great distention of the large intestine apparently down to about the level of the distal descending or sigmoid colon. The right half of the colon contained a considerable amount of fecal material. Marked dilatation and elongation of the overlapping distended loops of large bowel were observed (Fig. 1). A few loops of small intestine were seen to contain small quantities of gas, irregularly distributed. In the upper abdomen a few fluid levels were demonstrated, but there was no evidence of free gas in the peritoneal cavity. The roentgen appearance of the abdomen was consistent with a diagnosis of mechanical obstruction in the distal colon, probably distal descending or sigmoid. There was no evidence of a

[1] From the Department of Radiology, Mount Sinai Hospital, Milwaukee, Wis. Accepted for publication in January 1945.



Figs. 2 and 3. Spot roentgenograms made during barium enema examination, Jan. 13, 1944. The view on the left shows almost complete obstruction in the elongated sigmoid flexure. Twisting is demonstrated by the spiral mucosal pattern at the site of obstruction. The right-hand view, made shortly afterward, shows the process of untwisting, relieving the obstruction.

ruptured abdominal viscus. Barium enema examination was advised.

Barium enema examination performed the next day, Jan. 13, 1944, revealed almost complete obstruction in the sigmoid region (Fig. 2). The mucosal pattern indicated rotation or twisting of the large bowel in this region. As more opaque substance was carefully and slowly injected, untwisting occurred (Fig. 3) and the obstruction was gradually relieved and reduced. Filling of the entire colon then became possible, but one and a half to two gallons of barium sulfate were necessary for this, indicating the presence of megacolon. No other evidence of obstruction was demonstrated and there was no evidence of either a neoplastic or infiltrative lesion.

Re-examination of the colon on Jan. 14, 1944, two days after admission to the hospital, showed no evidence of obstruction or volvulus. Great dilatation and elongation of the entire colon were again observed (Fig. 4), but the dilatation was most conspicuous in the sigmoid region.

Clinical improvement followed the barium enema examination and the abdominal distention and tympany disappeared. The patient was dismissed three days after admission and has been in good condition ever since.

Fig. 4. Right anterior oblique roentgenogram after injection of 1 1/2 to 2 gallons of barium sulfate mixture. No signs of obstruction are present.

COMMENT

Megacolon or Hirschsprung's disease, in contradistinction to volvulus, occurs most frequently in the young. Johnson and Benson (2), in their discussion of the surgical treatment of megacolon, state that the acquired form is always secondary to an obstructive lesion. Congenital cases, however, may or may not be due to obstruction. It is claimed that the sigmoid is the

favorite site and that the rectum is involved in only one-third of the cases.

Grimson and his colleagues (3) believe that the prognosis depends upon the pathologic type of the disease. On this basis they classify patients with megacolon in three groups. Of the 24 cases in their series, 12 belonged in the first group, with immense dilatation of the entire colon plus definite dilatation of the rectum. Group 2, with severe dilatation of the colon down to the sigmoid and a normal rectum, included 7 cases. The prognosis in this group is poor. In the third group, accounting for the remaining 5 patients in the series, there is enlargement of the descending and sigmoid segments with or without involvement of the rectum and proximal colon. It is beyond the scope of this paper and the experience of the author to discuss the basic etiologic factors of megacolon. The reader is referred to Bockus (4), who considers the etiology under three headings: mechanical causes, inflammatory causes, deranged nervous mechanism.

Volvulus, the twisting of a portion of bowel about the axis of its mesentery, probably occurs with equal frequency in the sigmoid and ileum. Some statistics favor the sigmoid as the more common site; others the ileum. Increased length of the bowel and shortening of the mesenteric attachment are necessary for the development of volvulus. It occurs two to four times as frequently in the male as in the female, while for Hirschsprung's disease the corresponding ratio is 3 to 2. Volvulus is responsible for approximately 10 per cent of cases of mechanical intestinal obstruction and is more frequently seen after middle life. Weeks (1) discovered that only 13 per cent of the cases occur under the age of twenty. Some observers believe there is a greater tendency for volvulus to develop in Russians and Serbians. Whether anatomical factors, dietary habits, or both, are responsible for this apparent racial difference is difficult to explain. In the series reported by Grimson *et al.* (3), described above, there were 2 cases of volvulus in the first group.

The pathology of megacolon and volvulus is well presented and discussed by Bockus (4) and Martin and Ward (5). In the acquired and congenital forms of megacolon the muscular layers are hypertrophied. In the congenital forms, the myenteric plexus is atrophied, but there is some disagreement as to its status in the acquired cases. Some authorities say that it is atrophied while others believe that it is normal. Necrosis is not necessarily an accompaniment, or result, of volvulus. Fortunately there is a multiple blood supply, which probably prevents segmental necrosis in many instances. Superimposed infection in cases of complete rotation is probably the determining and aggravating factor in the production of necrosis. Statistics with reference to the direction of twist in volvulus are not complete, but Weeks (1) mentions that of 21 cases in the literature in which note was made of this feature, 15 showed clockwise and 6 counterclockwise rotation.

Weeks (1) emphasizes that the development of volvulus should be suspected when obstipation, abdominal distention, and acute abdominal pain occur in patients with megacolon. The symptoms of Hirschsprung's disease are ordinarily chronic and irregular. Constipation is always present, and the diarrhea often described is one of overflow. Tenesmus is frequently present. Attacks of volvulus give rise to thickening of the mesentery with subsequent shortening, and as the colon becomes increasingly elongated, the attacks become more frequent. With their repetition, the chances of reducibility decrease and the possibility of subsequent segmental necrosis becomes greater. The presence of fecal retention and impaction in a dilated colon which becomes obstructed or twisted predisposes to gangrene of the bowel as a result of secondary infection.

The clinical manifestations of volvulus will vary somewhat depending on the location of the obstruction. The sigmoid and ileum are the usual sites. Recently a case of volvulus of the transverse colon was reported by Martin and Ward (5). Physical

examination should reveal all the signs of mechanical intestinal obstruction.

A complete roentgen study of the abdomen for intestinal obstruction should include anteroposterior and postero-anterior studies in both the recumbent and erect positions, though this technic must sometimes be modified if the patient's condition does not permit of examination in the erect position. In such an event, recumbent anteroposterior or postero-anterior projections with the patient lying on either side can be substituted. Enemata should not be administered prior to original x-ray studies, as they cause confusing gas shadows and often make it impossible for one to render a definite diagnostic statement or differentiate between paralytic ileus and mechanical obstruction. Roentgen diagnostic methods enable one to localize the site of obstruction in the great majority of cases. Precise localization is possible by means of a barium enema. To be able to demonstrate the actual twisting of the mucosal pattern, as we did in our case of volvulus, is probably a matter of chance, depending mostly on the degree of rotation. In acquired cases of megacolon one should attempt to demonstrate the primary cause or organic lesion, such as atresia, an inflammatory lesion, or neoplastic condition.

The treatment of volvulus of megacolon is at best unsatisfactory and discouraging. The colon is usually filled with feces and the patients are often debilitated. Superimposed infection causes, or is responsible for, strangulation and segmental necrosis and accounts for the poor surgical results. As strangulation of the bowel carries a high mortality, regardless of the type of treatment, proper therapeutic measures should be instituted in the management of patients with megacolon to prevent the occurrence of volvulus. Experience gained in a single case does not qualify one to make recommendations, but a carefully administered enema before gangrene has set in might actually reduce the twisting, with subsequent recovery from the acute mechanical obstruction. Such a column of fluid evidently exerts an untwisting force, so to speak. Surely no harm can be done if the procedure is carried out with due precaution, as in cases of intussusception.

SUMMARY AND CONCLUSIONS

A case of mechanical intestinal obstruction due to volvulus of a sigmoid megacolon, reduced by a barium enema, is presented. The literature on the subject is briefly discussed and the probable frequency of volvulus in megacolon is stressed.

If the possibility of reducing a volvulus of megacolon by a conservative measure exists, as shown by our example, then one is justified in recommending the early and judicious administration of enemata in patients with megacolon who experience episodes of acute abdominal pain, distention, and obstipation.

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EDITORIAL

The Endocrine Glands and Cancer

Patients with advanced malignant growths should be, and in most cases are, treated palliatively with roentgen rays or radium. The alleviation of symptoms when these agents are properly employed, in appropriate dosage, is too well known to require comment, yet it is striking how often we see what is considered a cancerocidal dose administered to a hopelessly incurable patient. We must, unfortunately, consider three out of every four cases referred to us as incurable. In most instances it is obvious which patients have early and sufficiently localized lesions to receive cancerocidal quantities of radiation. In such cases even a severe reaction is a small price to pay for eradication of the neoplasm. In the hopeless cases, however, the radiation reactions are without such compensation and are frequently so severe that the patient suffers more from the treatment than from the disease.

This is well exemplified in the treatment of prostatic cancer, either with platinum radium needles or radon seeds, when the implantation must of necessity be performed blindly, without knowing the extent or size of the prostate gland. The same may be said of external radiation as a supplementary agent or alone, when given in large quantities. The pain and dysuria resulting from such measures are indeed excruciating, and many times treatment has hastened death.

Fortunately, the studies of Huggins and Hodges on the treatment of cancer of the prostate by orchiectomy and by injections of estrogen have ushered in a new therapeutic era. Now, five years following the appearance of their first report, this method represents an outstanding addition to the armamentarium of the treatment of cancer, not as a curative measure but as a palliative procedure that can bring about complete relief of symptoms for months or even years. In many cases metastatic bone deposits have disappeared; metastases which were not demonstrable in the roentgenogram prior to treatment have become visible by changing from osteolytic to osteoblastic lesions.

The radiation therapist may in some cases bring about similar results in premenopausal patients with metastasizing carcinoma of the breast, by giving a castration dose to the ovaries. Premenopausal metastases in bone from carcinoma of the breast are invariably osteolytic, but not infrequently they may become osteoblastic following castration. The percentage of women who obtain relief by this roentgen procedure is not high, but when favorable results are obtained, they are striking and very much worth while in younger women. There is no evidence to indicate that castration of the young woman is advisable as a routine measure following operation. It is, therefore, better to reserve this procedure for those cases with known metastatic involvement. It is difficult to foretell, prior to castration, which patient will obtain relief, but it has been noted (Sosman) that palliation is more likely in women with bony metastases who have increased pain and tenderness before and during the menstrual period than in those not similarly affected.

The glands of internal secretion are thus seen to have a direct bearing on cancer, and the employment of proper measures dictated by this relationship may prolong life and alleviate suffering from incurable cancer.

HUGH F. HARE, M.D.

Radiological Society of North America
The Thirty-First Annual Meeting

At the time of the 1944 Joint Meeting of the Radiological Society of North America with the American Roentgen Ray Society, the decision was made to formulate plans for the Annual Meeting of the Radiological Society in 1945, in spite of the undercurrent of feeling that transportation problems and crowded housing facilities might make this extremely difficult or even impossible.

Tentative arrangements for holding the meeting in Cleveland were made by the Board of Directors and the Program Committee, enlarged by the appointment of several additional members located geographically. The interest and effort of this rather large committee are attested by the program appearing on the following pages. Because of the widespread feeling that a meeting might not be held and the fact that all physicians have been extremely busy, the number of papers listed is comparatively small. We feel that there will be general agreement, however, after reading the following titles and abstracts, that those papers obtained are well worth while. These contributions will be published in RADIOLOGY.

In lieu of the regular meeting and in conformance with the Constitution and By-Laws, the Board of Directors has arranged for a "token" meeting, which will be held, with business sessions and reading of the program by title, at the Drake Hotel, Chicago, Nov. 9 and 10.

To those who have contributed to the program I wish to express the sincere appreciation of the Program Committee and our regret that your papers may not be presented in the customary fashion. I am indeed sorry that it is impossible to hold our regular Annual Meeting.

LEWIS G. ALLEN, M.D.
President

RADIOLOGICAL SOCIETY OF NORTH AMERICA

THIRTY-FIRST ANNUAL MEETING, CHICAGO, NOV. 9–10, 1945

SCIENTIFIC PROGRAM

To Be Presented by Title

DIAGNOSTIC SECTION

The Early Diagnosis of Carcinoma of the Lung. GJERT M. KELBY, M.D., Minneapolis, Minn., AND LEO J. RIGLER, M.D., Professor of Radiology, University of Minnesota.

Abstract: Although Westermark described the emphysema of the lung which may occur early in the course of a bronchogenic carcinoma some years ago, this sign has not been freely utilized in the attempt to diagnose tumors of the bronchus at an early stage. In some cases of carcinoma of the bronchus it is possible to demonstrate an obstructive emphysema of one lung, similar to that found with foreign bodies, and this may be one of the earliest signs of a tumor which has as yet incompletely obstructed the bronchus. Three cases are reported to demonstrate this finding. Rapid changes in the appearance of the lung may occur so that within a few weeks after the demonstration of emphysema the characteristic atelectasis of an obstructing bronchogenic tumor may eventuate. The early type of atelectatic change simulating pneumonia is described. It is possible by routine fluoroscopic examination, with particular attention to the expiratory phase, occasionally to demonstrate tumors of the bronchus which are almost symptomless.

Spondylolisthesis and Prespondylolisthesis: Their Frequent Occurrence in the Absence of Symptoms. WILBUR BAILEY, M.D., Assistant Clinical Professor of Radiology, University of Southern California, AND RICHARD R. HALL, M.D., Los Angeles, Calif.

Abstract: The presence of a defect in the isthmus or pars interarticularis of one of the lower lumbar vertebrae is usually first discovered after the patient has a history of injury or low-back pain. Examinations of over 1,000 young men, none of whom had such complaints, showed a surprisingly large number of these defects. The evidence would, therefore, indicate that such lesions are congenital rather than traumatic in origin.

Retrograde Abdominal Aortography: A Contribution to the Study of the Abdominal Aorta and Iliac Arteries. PEDRO FARIÑAS, M.D., Habana, Cuba.

Abstract: The pathology of the abdominal aorta has received little attention from clinicians due to the fact that there was no practical method for its exploration. With retrograde abdominal aortography for study of the abdominal aorta and iliac arteries, the technic is reduced to that of simple arteriography. That pathological changes of the aorta and its branches can be clearly visualized and studied is demonstrated.

The Recognition and Management of Congenital Atresia of the Esophagus. JOHN F. HOLT, M.D., CAMERON HAIGHT, M.D., Associate Professor of Surgery, AND FRED JENNER HODGES, M.D., Professor of Roentgenology, University of Michigan.

Abstract: On the basis of experience gained in the handling of some 50 infants born with congenital malformations of the esophagus associated with atresia, the importance of x-ray methods of examination is discussed and hints regarding useful diagnostic procedures are presented. Surgical procedures often successful in the re-establishment of esophageal continuity are described and illustrated with results which have been obtained in several instances. Infants born with major abnormalities of the esophagus present diagnostic problems which are of particular radiologic concern, and the ultimate fate of these children depends to a considerable extent upon close cooperation between radiologist and thoracic surgeon.

Small Intestinal Dysfunction Associated with Peripheral Nerve Disorders. FRED JENNER HODGES, M.D., Professor of Roentgenology, University of Michigan, AND R. WAYNE RUNDLES, M.D., Ann Arbor, Mich.

Abstract: The combined clinical and roentgenologic study of 150 patients presenting clinical evidences of peripheral neuropathy associated with various diseases shows a surprising correlation between x-ray-demonstrable dysfunction of the small intestine and the more commonly observed evidences of peripheral nerve disorders. Of particular interest is the frequency with which profound abnormalities of small bowel behavior can be demonstrated in patients with uncontrolled diabetes, a situation which to date has received little attention. The case material from which these observations are derived includes, in addition to the diabetic group, pernicious anemia, lead poisoning, vitamin B deficiency, inflammatory diseases of the intestinal tract, toxic polyneuritis, tabes dorsalis, and other conditions in which peripheral neuropathy is a feature. Small bowel function has been studied as well in a group of normal subjects and in persons before and

after splanchnic resection and before and after total gastric resection.

Sequelae of Injuries to the Urinary Tract: Roentgenological Considerations. ARTHUR P. ECHTERNACHT, Indianapolis, Ind.

Abstract: During the preparation of a previous paper on the roentgenologic considerations of injuries to the urinary tract, the author became intrigued by the following question: What permanent changes, if any, occur in the anatomical configuration of the kidneys, ureters, and bladder and in the excretory function of the kidneys following injuries to the urinary tract that have been treated conservatively? A review of the literature reveals a scarcity of information about this subject from the roentgenological aspect. The author reports the results of his investigations.

A New Roentgen Sign in Extra-Biliary Tract Diseases. SAMUEL BROWN, M.D., Assistant Professor of Radiology, University of Cincinnati, AND FOREST G. HARPER, M.D., Cincinnati, Ohio.

Abstract: The basis of the new roentgen sign in extra-biliary tract diseases depends upon the intimate anatomical relationship which exists between the duodenum and neighboring structures. The neck of the gallbladder, the cystic and the common ducts form a tubular ring which almost completely encircles the superior flexure of the duodenum, the freedom of mobility of which is limited by the liver above, the pancreas below, and the right kidney behind. When any part of the tubular system is dilated because of obstruction due to a stone or tumor or by an extrinsic mass, the superior flexure of the duodenum frequently suffers compression of its contour. Since the proximal portion of the duodenum is directed from before backward, the pressure defect is demonstrable roentgenologically only in the right lateral decubitus position. This sign has enabled us to diagnose diseases of the gallbladder, ducts, liver, and pancreas which could not be diagnosed by usual x-ray methods. It has also enabled us to differentiate between obstructive and non-obstructive jaundice, being present in the former condition but absent in the latter.

Several representative cases have been chosen for a more or less detailed discussion illustrating the value of this roentgen sign.

Amebic Infections of the Colon as Seen in an Army General Hospital. LT. COL. JOSEPH C. BELL, M.C., A.U.S.

Abstract: A review of the characteristic findings in this condition and discussion of the morphologic changes responsible for the abnormalities that may be shown by the roentgen ray. Case histories and roentgen ray findings of illustrative cases are presented.

Significance of the Sacroiliac Findings in Marie-Strümpell's Spondylitis. JONAS BORAK, M.D., New York City.

Abstract: Anatomical, pathological, radiological, clinical, and therapeutic considerations lead to the conclusion that the sacroiliac findings in Marie-Strümpell's spondylitis are merely a reaction of the sacroiliac bones to the immobilization of the lumbar spine resulting from the pathological process taking place in the small intervertebral joints. The sacroiliac reaction is unspecific. It occurs not only in Marie-Strümpell's spondylitis but also in many other conditions restricting the mobility of the lumbar spine. It also occurs in a number of conditions causing a limitation of mobility of the hips.

The first manifestation of Marie-Strümpell's spondylitis is found not in the sacroiliac region but in the area between the eleventh dorsal and second lumbar vertebra, most frequently between the twelfth dorsal and first lumbar. From the radiological point of view, there is first a preradiological phase, in which only clinical symptoms are present. It is followed by a spondylitic or pre-sacroiliac phase, in which certain radiological signs are found in the spine while the sacroiliac joints are not affected. From its first localization in the lower dorsal and upper lumbar spine the disease spreads in the ascending direction along the dorsal spine and in the descending direction along the lumbar spine. When the larger part of the lumbar spine is affected and, as a result, immobilized for a prolonged period of time, the sacroiliac reaction becomes apparent and the sacroiliac phase of the disease begins.

A Duodenal Mechanism Regulating the Motor and Secretory Activity of the Stomach: Its Disturbance in Duodenal Ulcer. LT. COMDR. JACOB GERSHON-COHEN (MC) USNR.

Abstract: This report is a summary of a series of experiments in man revealing the presence of a mechanism in the duodenum, stimulation of which accounts for the regulation of the motor and secretory activity of the stomach. Disturbance in the response of the mechanism in duodenal ulcer explains the abnormal motor and secretory activity of the stomach in duodenal ulcer. The report includes a short review of the work done in this field of gastric physiology.

A Clinical Study of Gallbladder Physiology with Roentgen Aid. DAVID S. DANN, M.D., Kansas City, Mo.

Abstract: The extensive experimental and clinical studies of the physiology of the gallbladder reported in the literature, while very valuable, are not entirely conclusive, since they were conducted under conditions which interfere with normal function. The writer has therefore undertaken a clinical investigation to determine normal func-

tion, particularly motor and concentrating activities, under conditions which more closely represent the normal mode of life of the specific individual.

Malignant Salivary Gland Tumors with Bone Metastases. C. LESLIE MITCHELL, M.D., AND G. A. CREEL, M.D., Detroit, Mich.

Abstract: Two long-standing parotid tumors, previously diagnosed as benign, later metastasized to bone and were subsequently shown to be malignant. Case histories of the two patients are presented, with a short discussion.

Medical and Hospital Insurance Problems. ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa.

Abstract: An attempt to prophesy inevitable changes in the methods of distribution of medical care, and a discussion of the means the organized medical profession must take to see that they are wise changes. A discussion of the position of radiologists in their relation to mass medical care, the dangers that threaten them, their weakness, and their strength. Some concrete suggestions as to what radiologists must do to insure that their specialty shall continue to endure.

The Fiftieth Anniversary of Roentgen's Discovery of the X-Rays. OTTO GLASSER, Ph.D., Cleveland, Ohio.

Applications of the Inverse-Square Law. ROBERT S. LANDAUER, Ph.D., Highland Park, Ill.

Abstract: There seems to be some doubt qualitatively, but with no quantitative evidence, regarding the application of the inverse-square law to comparatively short skin-target distances with oil-immersed tubes. This paper deals with the quantitative aspects of this problem.

A Practical Technic for Visualization of the Bronchial Tree. MAJOR GILBERT W. HEUBLEIN, M.C., A.U.S.

Abstract: The method of bronchography currently in use at the Percy Jones General and Convalescent Hospital is described. The type of anesthesia used is discussed and the technic for positioning illustrated by line drawings.

The American Board of Radiology. COL. B. R. KIRKLIN, M.C., A.U.S.

Abstract: A discussion of the standards, credit for military service, and future plans and policies of the American Board of Radiology.

Practical Aspects of Hip Nailing. HAROLD W. MORGAN, M.D., Mason City, Iowa.

Abstract: This paper covers a series of 60 consecutive cases treated by internal fixation with Smith-Petersen nail in a small general hospital surgical service. The special equipment used and modifications of previously published procedures which make possible completion of the entire procedure in from fifteen to twenty-five minutes are outlined. There is a report of the end-results so far as can be determined in this series of cases.

Heart Size from Standard Chest Films and Photofluorograms. PAUL C. HODGES, M.D., Professor of Roentgenology, University of Chicago.

Abstract: In ordinary stereoscopic chest films made without any attempt to synchronize the exposure with the cardiac cycle, there is seldom much difference in the size of the two cardiac shadows, and, when correction is made for divergent distortion, either silhouette may be accepted as reasonably comparable to the true frontal plane area of the heart. When the heart shadow is significantly larger in one film than in the other, the larger of the two will be found to be approximately the diastolic size. It is extremely improbable that, in making a stereoscopic pair, both films will show a silhouette significantly less than diastolic size. These facts have had wide tacit acceptance among clinicians. There is, however, much divergence in the opinions as to how the work-up of the silhouette should be done. Transverse diameter is easy but in cardiac disease, obesity, pregnancy, etc., is undependable. Computations based on the actual measurement of frontal plane area are dependable but rather cumbersome. This paper presents technical short-cuts that have been employed in our laboratory for several years and introduces the paper by Dr. Gerhart Schwarz in which the product of the long and short diameters of the silhouette is substituted for planimeter measurements of area. The product of diameters is applicable to either standard size films or miniature films but is particularly useful with the latter.

Correlation Between the Frontal Plane Area and the Product of Long and Short Diameters of the Cardiac Silhouette. GERHART SCHWARZ, M.D., Assistant in Radiology, University of Chicago.

Abstract: A review of the whole subject of roentgen-ray determination of heart size plus the introduction of an equation and nomogram by which frontal plane area may be computed from the product of the long and short diameters of the cardiac silhouette. The particular advantage of this approach is that it avoids the necessity of building up new standards of normal variation and makes it possible to employ the standards that have been accumulated through the years by those who have been measuring the frontal plane silhouette with a planimeter.

Congenital Partial Atresia of the Esophagus Associated with Congenital Diverticulum. R. P. O'BANNON, M.D., Fort Worth, Texas.

Abstract: A newborn infant showed signs and symptoms of congenital atresia of the esophagus with tracheo-esophageal fistula. Autopsy revealed the presence of partial esophageal atresia

with diverticulum. No similar case was found in a search of the literature.

Diagnostic considerations are discussed, and their importance is emphasized in view of the improvement recently achieved in surgery of congenital esophageal anomalies.

Diffuse Pulmonary Adenomatosis. L. W. PAUL, M.D., Associate Professor of Radiology, University of Wisconsin.

Abstract: Human pulmonary adenomatosis is a rare disease of unknown cause characterized by the development of multiple alveolar-cell adenomatous tumors. A brief review of this condition is given and five cases are reported in some detail. The roentgen changes are discussed and illustrated, together with the clinical and pathological findings of interest.

Cephalopelvimetry: Review of 400 Cases. L. A. SCARPELLINO, M.D., Kansas City, Mo.

Abstract: This paper is based upon over 400 cases of pelvic and cephalic measurements, with correction of the growth curve of the fetal head *in utero*, and correlation with the size of the fetal head after delivery. The films were made at various times in pregnancy, from fifteen weeks onward, and the fetal head size was calculated to the delivery date by use of the corrected growth curve. To date, such calculations—regardless of the time in pregnancy that the film is taken—appear to be in agreement with measurements of the delivered head, within an error of ±1 per cent. The method is applicable not only to vertex presentations, but also to breech presentations and twin pregnancies, instances of which are included. Furthermore, a practical method of measuring the asymmetrical pelvis is developed, based on the work of Ball and Marchbank with modifications.

Malignant Melanoma in Infancy: Report of Three Cases. PETER E. RUSSO, M.D., Oklahoma City, Okla.

Abstract: The three cases are as follows: (1) A congenital lesion in a five-weeks-old child proved by biopsy to be melanoma; (2) a similar condition observed in a three-year-old Indian girl, who came to autopsy; (3) a case in a three-year-old colored girl, who, although a metastatic lesion developed, has survived over three years without evidence of recurrence.

Pantopaque Myelography: Diagnostic Errors and Review of Cases. LT. COL. ROBERT C. PENDERGRASS, M.C., A.U.S., AND MAJOR GEORGE L. MALTBY, M.C., A.U.S.

Abstract: This paper deals with the technic, film interpretation, and results of Pantopaque myelography as carried out in an Army General Hospital. Special emphasis is laid upon sources of error in the diagnosis of ruptured intervertebral disks and upon the patterns obtained when the opaque medium is accidentally injected outside the subarachnoid space. The results of 215 Pantopaque myelograms are analyzed, with comparison of the roentgenologic and operative findings in 57 cases. Apparatus used is briefly described, with special mention of a simple device for supporting the fluoroscopic screen above the patient and for obtaining spot films.

Diffuse Calcification of the Pancreas. MAJOR ARTHUR J. PRESENT, M.C., A.U.S., AND MILTON J. GEYMAN, M.D., Santa Barbara, Calif.

Abstract: Diffuse calcification of the pancreas, though rarely reported, probably occurs more frequently than is suspected. The criteria for the diagnosis are presented, with report of two cases.

The Last-Straw Principle in Lower Back Disability. W. WARNER WATKINS, M.D., AND R. LEE FOSTER, M.D., Phoenix, Ariz.

Abstract: This paper is based on a study of 100 cases of lower back disability without visible bone injury, evaluated by the Medical Advisory Board of the Industrial Commission of Arizona, 1934 to 1942.

Some forms of arthritis, especially in the osteoarthritic group, are good examples of attempts at adaptation to stresses on joints or periarticular structures. Such adaptation may be effective over a considerable period, but may finally fail in connection with some trivial stress which represents the "last straw," breaking the adaptation to a long chain of slowly developing changes. When this point is reached and pain develops, with or without trauma, the back is likely to remain painful, unless a persistent and individualized treatment regime is applied to restore the adaptive control of the situation.

Careful study of the x-ray appearances, tracing the development of bone changes, is often helpful in understanding the symptoms and is a good example of the fine art of roentgen interpretation in conjunction with clinical observations.

Roentgen Studies Concerning the Collapsibility of Tuberculous Cavities. ERNST A. SCHMIDT, M.D., Professor of Radiology, University of Colorado, AND CHARLES J. KAUFMAN, M.D., Denver, Colo.

Abstract: The determination of the presence and character of cavitation is of paramount importance in pulmonary tuberculosis not only with regard to prognosis and principles of treatment in general but even more so with regard to the indications for collapse therapy in particular. As a rule, the ordinary inspiration roentgenogram furnishes sufficient information concerning the size, location, wall thickness, and other morphological characteristics of cavities. However, it frequently permits only indirect or inconclusive deductions regarding the collapsibility of the cavities.

The authors have studied the behavior of such cavities under varying physiological and pathological conditions which produce changes in the volume and pressure factors of the thoracic cage (different respiratory phases as well as Mueller's and Valsalva's experiments) and have complemented these findings by tomographic studies. They discuss the practical application of their findings with regard to prognosis and selection of treatment methods.

Bronchography: Method; Anatomical and Pathological Considerations. HUGH F. HARE, M.D., and MAGNUS I. SMEDAL, M.D., Boston, Mass.

Abstract: An analysis of the various methods of bronchoscopy is undertaken. The combined intratracheal and fluoroscopic method has been found a most satisfactory procedure.

The anatomy of the bronchial tree following the classification of Adams and Davenport is discussed.

Some Clinical and Roentgenological Observations of Yaws in the Southwest Pacific Area. MAJOR WALTER J. STORK, M.C., A.U.S., AND MAJOR CARL W. FLEET, M.C., A.U.S.

Abstract: Yaws is the most common disease of the bones, joints, and skin in the tropics. Both acute and chronic cases were observed by the authors in their tour of duty. A series of 886 cases was followed for a period of several months, including the juxta-articular type, goundou, gangosa, crab yaws, and hyperkeratotic types. The roentgen findings in the skeleton are discussed, as well as the clinical and laboratory observations.

Trauma is considered an etiologic factor. That the disease is non-venereal is concluded from the clinical findings and observations. The skin lesions, which are often multiple, have a predilection for the region of the anus and buttocks. Response to arsenicals is dramatic. Symptoms are relieved; large ulcers heal in a few weeks; sclerotic consolidation changes in bone lesions are not unusual. Penicillin produced excellent results in one case of the gangosa type.

Cardiac Roentgenokymographic Findings in Myasthenia Gravis. RICHARD C. BATT, M.D., Berlin, N. H.

Abstract: In 1939 the author detected cardiac roentgenokymographic changes in patients from the myasthenia gravis clinic of the Massachusetts General Hospital. Changes were constantly observed following a test dose of prostigmine. Previous cardiac studies on these patients had all been negative. Although this study shows that there are no characteristic kymographic changes in the heart in myasthenia gravis, kymograms made in the upright position frequently show a slight retardation of the heart rate after prostigmine. Deceptive changes in wave form are constantly produced by this altered heart rate. The chief value of the paper is its revelation of the commoner pitfalls which the unwary physician may encounter in roentgenokymographic diagnosis.

The Range of Usefulness of Intravenous Pyelography. LEONARD A. MYERS, M.D., Houston, Texas.

Abstract: A discussion of the scope of excretory urography in the interpretation of kidney and bladder pathology; preparation of the patient; procedure of examination, with emphasis on individualized attention to the functional status of both kidneys, proper ureteral compression at the period of maximum clearance thrust, a more complete ureteral study, and use of concentrated media for cystographic study.

Coccidioidomycosis with Special Reference to Protracted Primary and Post-Primary Involvement. RAY A. CARTER, M.D., Clinical Professor of Medicine (Radiology), University of Southern California, AND MAJOR HORACE JAMISON, M.C., A.U.S.

Abstract: A correlation of the experience with coccidioidomycosis in a military hospital with that of the Los Angeles County Hospital. A consideration of questions of prognosis, presenting manifestations which are apt to be encountered, and the acute progressive disease in contrast to chronic involvement.

Eosinophilic Granuloma of Bone. LT. COL. JOHN B. HAMILTON, M.C., A.U.S., MAJOR JOHN L. BARNER, M.C., A.U.S., CAPT. PUTNAM C. KENNEDY, M.C., A.U.S., 1ST LT. JAMES J. MCCORT, M.C., A.U.S., AND LT. COL. HANS F. SMETANA, M.C., A.U.S.

Roentgen Findings in and about Lesions of the Shoulder Joint. HARRY A. OLIN, M.D., Associate Professor of Radiology, Chicago Medical School.

Giant-Cell Tumor of Soft-Tissue Origin. MAGNUS I. SMEDAL, M.D., Boston, Mass.

Papers also to be contributed by D. A. RHINEHART, M.D., AND B. A. RHINEHART, M.D., Little Rock, Ark., and by E. R. WITWER, M.D., Detroit, Mich.

THERAPY SECTION

Cancer of the Breast: A Study of Patients Treated over a Period of Twenty Years in the Radiation Therapy Department of Bellevue Hospital. IRA I. KAPLAN, M.D., Professor of Clinical Surgery, New York University Medical School, AND RIEVA ROSH, M.D., Instructor in Surgery, New York University.

Abstract: Patients are divided into three large groups: those who came directly to Bellevue

Hospital for a primary breast condition; those referred from other hospitals for irradiation following surgical procedures; those referred from other institutions or physicians for custodial care or treatment for advanced mammary cancer.

Questions of race, age, marital status, lactation, extent and character of the lesion, the presence or absence of metastases are discussed. The relationship of pregnancy and breast cancer is considered.

The methods of irradiation employed are given in detail. Evaluation is attempted of the effect of other forms of therapy used in some cases. The treatment of advanced cases is described. Statistical data are presented, with determination of results as far as possible.

Five Years Experience in General Therapy. ASA SEEDS, M.D., Portland, Ore.

Abstract: Observations on a small teaching tumor clinic and the distribution of service to the public. A philosophic analysis of the opportunities as well as the requirements of a general treatment clinic, both tumor and non-tumor.

Present Status of X-Rays in the Prevention and Treatment of Infections. JAMES F. KELLY, M.D., Professor of Radiology, Creighton University, Omaha, Nebr.

Abstract: Experimental and clinical investigations of x-rays in the prevention and treatment of infections during the past fifty years prove conclusively that the rays affect living cells in a relatively short time, and, as a result, the patient's resistance is increased.

Where irradiation precedes the introduction of the infectious organism or its toxin, an immunity may be found to exist. This effect is easily demonstrated in infections associated with a severe toxemia, such as surgical mumps, gas gangrene, some forms of acute peritonitis, and erysipelas, in which an immunity of short duration may be found. This antitoxic effect of the x-rays may also be noted in some of the more chronic infections, as tuberculous lymph nodes in the neck. It is hoped that the data presented in this paper will lead to a more complete study of some of the infections which, up to this time, have failed to respond favorably to the x-rays but which should do so if irradiation could be given at the proper time and in proper amounts.

Since apparatus capable of influencing infectious diseases is found practically everywhere and its proper use carries little danger, radiotherapy of infections should be encouraged and used by all honest practitioners.

Irradiation in the Treatment of Hypertrophy of the Tonsils and Postpharyngeal Lymphoid Tissue. ANTHONY F. ROSSITTO, M.D., Wichita, Kans.

Abstract: The use of x-rays for infected and enlarged tonsils and adenoids, especially in young children, holds an enviable position in the treatment of these conditions. Roentgen therapy is not used to displace surgical treatment but to forestall surgery. Results seem to indicate that when the lymphoid hypertrophy has been reduced and the infection removed by irradiation, no other therapy is indicated. Because of the consistently good results, the method should be advocated more generally and the treatment should be recognized and encouraged by more radiologists.

Painful Shoulder: Its Diagnosis and Treatment. W. I. LEFEVRE, M.D., Cleveland, Ohio.

Abstract: Discussion of non-traumatic cases only. Diagnosis made both clinically and with plain anteroposterior view of the shoulder. X-ray finding usually negative. Most cases classified as "neuritis" or "bursitis." Treatment with low-voltage x-rays; technic given in detail.

Photography as an Aid in Treating Lesions of the Cervix. CHARLES F. BOWEN, Columbus, Ohio.

Abstract: The most difficult problem in treating lesions of the cervix is to be able to recall (or to have on record) how each looked at each visit. With perhaps fifteen or twenty cases, requiring frequent visits, it is difficult to remember details. With superficial lesions on the body, I have always made photographs as part of my records. After several years of experimenting, I have devised an arrangement of lights which makes it possible to obtain similar records in the case of the cervix. This consists of a ring of lights which fits over a cylindrical speculum. Any type of camera can be used and pictures of any size can be made, either in black and white or in colors.

X-Ray Therapy in Some Common Diseases of the Eye. DALTON KAHN, M.D., Toledo, Ohio.

Abstract: X-ray therapy is indicated in the treatment of many diseases of the eye, especially those accompanied by infection. The relief of pain and of excessive lacrimation is usually manifest in six to eight hours. In some of our cases of corneal ulcer complete healing occurred in forty-eight hours. Small doses with filtration were used in all instances. No damage has been noted as a result of irradiation. Two cases of glaucoma are reported with spectacular relief of pain, although the tension was not lessened.

Eosinophilic Granuloma: Case Reports; Lymph Node Involvement and Therapy. CARROLL C. DUNDON, M.D., AND THOMAS C. LAIPPLY, M.D., Cleveland, Ohio.

Abstract: Eosinophilic granuloma is a destructive lesion of bone which may produce a periostitis and an adjacent soft-tissue mass. Regional lymph nodes may be involved. Lesions have been described in almost all large bones of the body. The

incidence is greatest in the first and second decades of life. The characteristic cell is the histiocyte and there may be many or few eosinophilic leukocytes.

Four cases are presented. One of these patients, a girl 17 years of age, had severe constitutional symptoms which were thought by the clinician to certainly indicate a malignant tumor. A chest wall mass which surrounded the lesion of the sternum measured 12 × 11 × 4 cm. in size. It was not controlled by 1,600 r (air) of high-voltage radiation, but responded to an additional dose of 2,100 r (air). Biopsy was done before and after irradiation. A 6-cm. lymph node of the right axilla showed the typical picture of eosinophilic granuloma. Other lymph nodes were controlled by irradiation. The patient has remained well for six months.

Lymphoepithelioma. GALEN M. TICE, M.D., Assistant Professor of Radiology, University of Kansas.

Abstract: An uncommon, radiosensitive tumor occurring in the nasopharynx. Summary of the literature and report of twelve cases.

Liposarcoma. NORMAN MCCORMICK, M.D., Windsor, Ontario.

Abstract: Considerable difference of opinion prevails as regards the radiosensitivity of liposarcomas. Very few instances are recorded in which radiation in adequate dosage has been employed in their management, and brief and incomplete periods of follow-up examination detract considerably from the value of many papers. A satisfactory mode of treatment has not been attained, as, with the possible exception of the less malignant forms, local recurrence and ultimate death from metastasis is the rule.

A single case of liposarcoma, confirmed histologically, has been encountered by us among a series of more than 2,100 cancer patients. This case is reported with clinical photographs of the patient before and after operation, x-rays of the chest, photographs of the pulmonary metastasis, and photomicrographs of the original tumor and its recurrence.

THE CARMAN LECTURE

R. R. NEWELL, M.D., Professor of Radiology at Stanford University, San Francisco, well known for his work in radiation therapy, was chosen by the Program Committee to present the Carman Lecture. His subject was to have been "The Influence of Quality (Wave Length) in Radiation Therapy." The lecture will be presented later in RADIOLOGY as a printed essay.

ANNOUNCEMENTS AND BOOK REVIEWS

NOTICE TO DIPLOMATES OF AND CANDIDATES FOR AMERICAN BOARD OF RADIOLOGY

In order to facilitate the mailing out of notices, it is requested that all diplomates of The American Board of Radiology and candidates for certificates who have been in the Armed Services, or for any other reason have changed their addresses in the past two years, notify the undersigned immediately of their present address or an address at which mail will always reach them.

B. R. KIRKLIN, M.D.
Mayo Clinic
Rochester, Minn.

NORTH CAROLINA RADIOLOGICAL SOCIETY

The Fall Meeting of the North Carolina Radiological Society was held at Watts Hospital, Durham, October 5 and 6. Papers were presented by C. L. Gray, M.D., of High Point, N. C.; James E. Hemphill, M.D., of Charlotte; George Baylin, M.D., of Durham; G. B. Murphy, M.D., of Asheville; Paul P. McCain, M.D., of the State Tuberculosis Sanatorium; J. Lamar Callaway, M.D., of Durham; Robert J. Reeves, M.D, of Durham; Vincent Archer, M.D., of Charlottesville, Va.; Hugh F. Hare, M.D., of the Lahey Clinic, Boston, Mass.

SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

The Second Inter-American Congress of Radiology, originally scheduled to meet in Habana, Cuba, Jan. 19–24, 1946, under the presidency of Dr. Pedro L. Fariñas, has been postponed to Nov. 17–22, 1946. It is hoped that by that date adequate transportation and entertainment facilities can be assured.

A REQUEST FROM THE RADIOLOGISTS OF FRANCE

From Dr. Robert Coliez, President of the Hospital Radiologists of Paris and Vice-President of the Association of French Radiologists, there comes a letter of greeting from French radiologists, with the request that their American colleagues forward to them reprints of papers published since 1938, dealing with all aspects of radiology, electrotherapy, and cancer research and control. Reprints should be addressed to Dr. Coliez, 25, Rue Franklin, Paris, XVIème, France.

"The French radiologists," writes Dr. Coliez, "send to their colleagues of America the expression of their best thanks as well as that of their vivid admiration for the help given and the sacrifices they have accepted for the victory of the Allied Nations."

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE INTERVERTEBRAL DISC, WITH SPECIAL REFERENCE TO RUPTURE OF THE ANNULUS FIBROSUS WITH HERNIATION OF THE NUCLEUS PULPOSUS. Second Edition. By F. KEITH BRADFORD, M.D., Houston, Texas, and R. GLENN SPURLING, M.D., Louisville, Kentucky. A volume of 192 pages, with 70 illustrations. Published by Charles C Thomas, Springfield, Ill., 1945. Price $4.00.

THE MEDICAL ANNUAL 1945. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Editors: Sir HENRY TIDY, K.B.E., M.A., M.D. (Oxon.), F.R.C.P., and A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S. Published by John Wright & Sons Ltd., Bristol, and Simpkin Marshall (1941) Ltd., London.

Book Reviews

PULMONARY TUBERCULOSIS IN THE ADULT: ITS FUNDAMENTAL ASPECTS. By MAX PINNER, M.D., Chief, Division of Pulmonary Diseases, Montefiore Hospital for Chronic Diseases, New York; Editor, American Review of Tuberculosis; Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University, New York. A volume of 579 pages, with 59 illustrations and graphs. Published by Charles C Thomas, Springfield, Ill. Price $7.50.

This book clearly merits the attention of all who are interested in pulmonary tuberculosis from any angle since it is extremely logical in its presentation of the known facts of the disease, emphasizing its fundamental aspects, and represents an interpretation by an outstanding phthisiologist.

The text contains the important references bearing on the subject and is illuminated by the author's clearly expressed opinions on many therapeutic points concerning which there has been a good deal of past controversy.

It should be a valuable addition to any medical library.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N.Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Gordon King, M.D., Children's Hospital, San Francisco.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Acting Secretary, Frederick H. Rodenbaugh, M.D., 490 Post St., San Francisco. Meets annually with California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., U. S. Naval Hospital, San Diego, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month, Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, J. F. Pitman, M.D., Blanche Hotel Annex, Lake City.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meets in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Cedar Rapids. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Charles N. Davidson, M.D., 101 West Read St., Baltimore 1.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

Michigan Association of Roentgenologists.—Secretary, Bruce MacDuff, M.D., 201 Sherman Bldg., Flint 3.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

St. Louis Society of Radiologists.—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society.—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hos-

pitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

New Hampshire Roentgen Society.—Secretary-Treasurer, Richard C. Batt, M.D., St. Louis Hospital, Berlin.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., East Rockaway, L. I.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo A. Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gian Franceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings in January, May, and October.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Wm. Snow, M.D., 941 Park Ave., New York 28.

Rochester Roentgen-Ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meets in May, and October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, Charles Heilman, M.D., 1338 Second St., N., Fargo.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

Philadelphia Roentgen Ray Society.—Secretary, Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

Pittsburgh Roentgen Society.—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24. Meets second Wednesday of each month at 6:30 P.M., October to May, inclusive, at The Ruskin, 120 Ruskin Ave.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, M.D., Baylor Hospital, Dallas.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society in September.

University of Wisconsin Radiological Conference.—Meets first and third Thursdays, 4 to 5 P.M., September to May, inclusive, Room 301, Service Memorial Institute, 426 N. Charter St., Madison 6.

CANADA

Canadian Association of Radiologists.—Honorary Secretary-Treasurer, J. W. McKay, M.D., 1620 Cedar Ave., Montreal.

La Société Canadienne-Française d'Electrologie et d Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meets monthly.

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THE HEAD AND NECK

Basilar Impression Resembling Cerebellar Tumor: Report of a Case. Donald L. Custis and A. Verbrugghen. Arch. Neurol. & Psychiat. **52:** 412–415, November 1944.

The authors add another case to the 19 instances of platybasia previously reported by American observers. The condition is generally considered as a developmental anomaly of the craniovertebral boundary characterized by an invagination of the basiocciput due to upward projection of elements of the atlas and axis. The atlas is commonly fused with the occiput. This bony malformation results in encroachment on adjacent neural structures, notably the medulla, cerebellum, cranial nerves, and upper cervical cord. It is difficult, however, to explain why symptoms first appear in adults rather than in children.

The diagnosis rests on roentgenographic demonstration of an appreciable part of the odontoid process above a line drawn from the posterior border of the foramen magnum to the posterior portion of the palatine bone.

The authors' patient was a 55-year-old man with a two-and-a-half-year history of progressive gait instability, as well as other cerebellar signs. Positive roentgenographic signs were present and at operation the cerebellar tonsils were found to be displaced under the lamina of the atlas. Beneath this was a definite bulge of the medulla.

Surgical decompression, including the removal of any constricting bone, dura, or arachnoid, is advocated.

EDWIN O. PEARSON, M.D.
(University of Michigan)

Lateral Movement in the Atlanto-Axial Joints and Its Clinical Significance. J. Dankmeijer and B. J. Rethmeier. Acta radiol. **24:** 55–66, Feb. 28, 1943. (In English.)

The authors have made investigations of the possibility of lateral movements of the atlas in relation to the axis, using cadaver material and living subjects. From their observations they conclude that a lateral mobility of the axis in relation to the epistropheus is to be regarded as normal. Roentgenologically these movements can be recognized by an asymmetrical position of the odontoid process in the foramen and by the changed position of the articular surfaces. An asymmetrical position of the odontoid process, however, may also be caused by movement of the axis in relation to the atlas or by an anomaly in the structure of the axis. In view of these observations, prudence is advised in the interpretation of such asymmetry as indicative of an atlas luxation.

MAX SGALITZER, M.D.

THE CHEST

Simple Method for Taking Stereoscopic Chest Films. Stuart P. Hemphill and Melbourne W. Diercks. U. S. Nav. M. Bull. **44:** 166–169, January 1945.

The authors describe the use of a sheet of Masonite board, 1/8 in. thick, attached by metal clips to the front of a vertical cassette holder, for taking stereoscopic chest films. The patient is positioned against the board and, without disturbing him or changing his position, the films are inserted in the grooves of the cassette holder. With two persons—one to manipulate the controls of the x-ray machine and shift the x-ray tube between exposures and another to change the cassettes—it was found possible to obtain satisfactory stereoscopic radiographs of the chest within 15 seconds, during which time the average patient can easily suspend respiration in inspiration. This arrangement is not quite so satisfactory as a mechanical plate changer, but inexpensiveness and simplicity make it a valuable addition to ordinary roentgen procedures. With this device, stereoscopic films of other parts of the body, as the skull, cervical and thoracic spine, clavicle, ribs, sternum, and shoulder joints, can be made in addition to chest roentgenograms.

BERNARD S. KALAYJIAN, M.D.

Acute Suppurative Bronchopneumonia. Harold Neuhof and Alexander Thomas. Arch. Int. Med. **75:** 45-64, January 1945.

Suppurative bronchopneumonia is the term applied by the authors to the type of bronchopneumonia characterized by suppuration within the parenchyma. Their study is based upon 120 proved cases of this condition seen at Mount Sinai Hospital, New York.

The seasonal incidence of suppurative bronchopneumonia corresponds apparently with that of other forms of bronchopneumonia. As a rule, the disease occurs in persons otherwise apparently healthy, with a higher incidence in children than in adults. The pathogenesis of suppurative bronchopneumonia and non-suppurative aspiration pneumonia seems to be identical. Suppurative pneumonia is often preceded by an infection of the upper respiratory tract and is characterized by fever, cough, and the expectoration of purulent sputum. Thoracic pain occurs early and is sufficiently common to be regarded as a feature of the disease. Physical signs are not distinctive. The pathologic features consist of a severe bronchopneumonia involving one, several, or many portions of the lung or lungs. Spread from primary areas appears to be chiefly by the mechanism of spill-over. Suppurative pleuritis, circumscribed or diffuse, is a common complication. There is no distinctive bacteriologic agent for suppurative bronchopneumonia. One or more of the aerobic pyogenic organisms, most commonly *Staphylococcus aureus*, hemolytic streptococci, and pneumococci, are encountered.

Suppurative bronchopneumonia usually can be diagnosed readily on the basis of the clinical features. When it pursues a prolonged course, it must be differentiated from other causes of pulmonary suppuration, notably, tuberculosis, neoplasm, fungous infection, and even putrid pulmonary abscess.

The roentgen findings in suppurative bronchopneumonia are extremely varied and often bizarre. The occurrence of one or more areas of rarefaction in the midst of pneumonic infiltration was found to be pathognomonic, but such areas are not seen in all cases. They may be revealed by laminagrams when not visible in ordinary films. Other roentgen features, which are encountered so frequently that they can be regarded as

characteristic of the disease, have been classified by Rabin (J. Mt. Sinai Hosp. **8:** 32, 1941) as follows: (1) interstitial infiltrations about the bronchi, blood vessels, and interlobular septa; (2) homogeneous densities, either single or multiple, of lobular, segmental, or lobar distribution; (3) changes indicating the presence of focal, segmental, or lobar atelectasis or emphysema; (4) multiple areas of rarefaction indicating the presence of a destructive process within the lung or bronchi; (5) single abscess cavities of varying size; (6) collections of fluid and air within the pleural cavity which may obscure the intrapulmonary changes. These features may exist separately or in various combinations. Roentgenograms which reveal large so-called balloon cavities are of special interest. These thin-walled cavities may be seen in films after apparent complete subsidence of pulmonary infection.

Chemotherapy, including the newer sulfonamide drugs, and serum therapy proved disappointing in the authors' series of cases. Treatment is primarily supportive and when vigorously pursued may greatly facilitate recovery.

Cases are presented illustrating the clinical varieties of the disease, namely the basic localized and diffuse forms, secondary suppurative bronchopneumonia occurring postoperatively or from some other primary cause, and the surgical forms—pulmonary abscess and empyema and pyopneumothorax. Examples of cerebral, septic, and local complications (lattice lung and bronchiectasis) are also presented. Intrathoracic complications account largely for the mortality in suppurative bronchopneumonia. The principles of their surgical management are discussed.

Atypical Pneumonia. By the Commission on Acute Respiratory Diseases. Am. J. M. Sc. **209:** 55–58, January 1945.

Primary atypical pneumonia is an acute infection of the respiratory tract, presumably transmitted from person to person by contact, droplets, or droplet nuclei. It may be one or it may be several diseases produced by one or many agents. It may vary from the mildest infection to the most severe and fatal pneumonia. It is by far the most important type of pneumonia in the Army.

It usually begins gradually, with headache, malaise, fever, and chilliness. A dry, irritating, sometimes paroxysmal, cough develops soon after onset. A roentgenogram of the chest will show evidence of infiltration in a large proportion of the cases. As the disease progresses, the cough becomes productive. Physical signs of involvement of the smaller bronchioles appear. Most of the patients are moderately ill from three to eight days, but convalescence is prolonged. Recovery is the rule. Variations from this usual picture may be extreme. Some patients may be sick for weeks, and secondary bacterial infections may develop. Others may be so slightly ill that they continue to work, and only a chest roentgenogram will reveal the presence of the disease. In another group of cases, called "suspected atypical pneumonia," the symptoms are as given above but the chest roentgenogram is normal. These patients have physical signs of pulmonary involvement, however.

The etiology of this disease is still unknown. A clear-cut relationship between the many viruses isolated by animal inoculation and the human disease has not been established. Transmission experiments in human volunteers using throat washings and sputa of patients with the disease suggest that it is an air-borne infection.

Atypical pneumonia has shown no specific concentration with respect to race, sex, or geographic area, except in hospital personnel, in whom the incidence is significantly high. Attack rates in certain of the epidemics have varied from 14 to 40 per cent.

It seems reasonable to consider atypical pneumonia as a more severe form, with pulmonary involvement, of undifferentiated respiratory disease. Proof must await further etiologic studies, but it may be said that this "disease" may constitute a large part of the problem of respiratory illness. Thus far, no intermediary vectors, such as food or insects, have been incriminated. Contact, droplet, and air-borne methods of transmission appear to provide the manner of spread.

BENJAMIN COPLEMAN, M.D.

Primary Atypical Pneumonia of Unknown Cause, with Unusual Manifestations and Complications. Robert E. Glendy, Samuel B. Beaser, and Walter D. Hankins. Arch. Int. Med. **75:** 30–38, January 1945.

The 150 cases of primary atypical pneumonia which form the basis of this report were derived from a total of 180 cases of pneumonia of all types encountered at an Army station hospital from Sept. 1, 1942, to June 1, 1943. Complications noted among the 150 cases were: meningismus in 3 cases, pleural effusion in 4, pronounced leukopenia in 1, infiltration simulating tuberculosis and a spontaneous pneumothorax in 1, pulmonary abscess in 4, and late secondary infection in 2. A number of these cases are presented in detail.

One of the cases of primary atypical pneumonia with meningitis illustrates the complete ineffectiveness of sulfadiazine in primary atypical pneumonia and infection of the throat by secondary invaders late in the disease. Another is of particular interest because of the presence of leukocytes in the spinal fluid, with a late secondary infection of the middle ear.

The authors call special attention to the roentgen features in the cases of atypical pneumonia with pleural effusion. Clinically it was noted that effusion occurred in patients with severe symptoms, a considerable degree of prostration, a high remittent fever, and a strong tendency to relapse. One patient had a leukopenia with a marked outpouring of immature cells in addition to the pleural effusion. The white blood cells rose on the day of defervescence, but the abnormal cells persisted longer. The patient was allowed up before the fluid was completely absorbed and had a relapse, which was accompanied by spread to the upper lobe of the right lung without further hemopoietic complications.

In one case the pneumonia simulated tuberculosis, with a subsequent spontaneous pneumothorax. The patient was admitted to the hospital with a manic depressive psychosis. Physical examination seemed essentially normal, and the temperature was normal throughout the period of hospitalization except for an elevation to 99° F. on the first two afternoons. Roentgenograms of the chest taken two weeks after admission showed a soft cottony infiltration in the infraclavicular region extending out into the first interspace from the hilus. Subsequent films showed complete clearing of the infiltration, but a small apical pneumothorax, extending down as far as the first and second interspaces.

The cases of pneumonia with a putrid pulmonary

abscess presented here are unlike those reported elsewhere. The resemblance of this lesion to tuberculous cavitation, especially when located in the upper pulmonary fields, is noteworthy. Tuberculosis was ruled out in the authors' cases by the clinical course and laboratory studies. The abscess seemed to be the result of infection by secondary invaders during convalescence, occurring on the nineteenth, thirteenth, sixteenth, and forty-second day in the 4 patients with this complication. The only death in the entire series was in a case of secondary infection with pulmonary abscess and empyema.

Two cases illustrate the occurrence of fever, leukocytosis, spread of the pneumonia, and prompt response to sulfonamide compounds during convalescence.

Numerous roentgenograms are reproduced.

Bronchography in Pulmonary Tuberculosis: Chronic Fibroid Phthisis—Chronic Productive Tuberculosis. B. A. Dormer, J. Friedlander, and F. J. Wiles. Am. Rev. Tuberc. **51:** 62–69, January 1945.

Chronic fibroid phthisis is a difficult type of tuberculous disease to treat. Many patients have had the disease for years with sputum positive for tubercle bacilli and with the diagnosis made more or less by accident. Treatment seems well-nigh impossible because of the almost universal bilateral nature of the disease, its extent, and the low vital capacity and dyspnea which accompany it. Bronchography has been found to demonstrate the essential lesions much more clearly than conventional radiography. The pathological development seems to follow the course of bronchial block with atelectasis and pneumonitis, to be followed by bronchiectasis and excavation. Suspension of sulfonamide powder or sulfadiazine, as much as 2 gm. to each 5 c.c. of iodized oil, was found to improve the clarity of the bronchograms. In 3 cases repeated instillations of this mixture resulted in the disappearance of tubercle bacilli from sputum which had been positive for many years. It is suggested that this suspension may sterilize chronic bronchiectatic areas and cavities in cases of this type. This same form of treatment was used preceding major surgery, as thoracoplasty, and the postoperative course appeared to be smoother in all respects than in any earlier series of cases. Ten case reports with reproductions of bronchograms are included. L. W. PAUL, M.D.

Radiological Findings in Tracheo-Bronchial Tuberculosis. C. C. Birkelo and L. A. Poznak. Dis. of Chest **11:** 26–35, January–February 1945.

Endobronchial tuberculosis is commonly found in small and large bronchi near the cavities which they drain. It is seen less frequently at points distant from cavities. Bronchoscopy is the method of choice both for diagnosis and treatment, but frequently reliance must be placed on the physical and roentgen examinations in selecting cases for bronchoscopic study. The authors group certain suggestive x-ray findings as direct and indirect. The direct findings are as follows:

(1) Small areas of atelectasis without visible shift, usually in an apex, resulting from occlusion of smaller bronchi.

(2) Sudden consolidation of a lobe in a partially collapsed lung. This may be due to a blood clot, but it may be the result of a bronchial ulceration with stenosis and is a direct indication for bronchoscopy.

(3) Sudden spread of a lesion which had been apparently controlled by pneumothorax or other collapse procedure.

(4) Sudden variation in size of cavities or a cavity with considerable fluid. This may be caused by stenosis, kinking of a bronchus, or endobronchial tuberculosis, such as a tuberculoma or ulceration with stenosis. Failure of a cavity to close or diminish in size following adequate collapse measures also indicates bronchial occlusion.

(5) Endobronchial tuberculosis should be suspected in far-advanced disease with multiple and bilateral excavations.

Indirect signs of tracheobronchial tuberculosis are (1) hemoptysis of the mild or streaking type without demonstrable x-ray changes; (2) positive sputum without a demonstrable cavity; (3) persistent non-productive cough with minimal roentgen findings.

The authors add a table showing the results of bronchoscopic examination in 565 cases, which they group as "prior to collapse" (224 cases) and "suspected tracheobronchial disease" (341 cases). In 417 the examination was negative; ulceration or stenosis was present in 148.

[This paper is one of a Symposium on Tracheobronchial Tuberculosis presented before the American College of Chest Physicians, comprising this entire issue of Diseases of the Chest.] HENRY K. TAYLOR, M.D.

A Particular Type of Tuberculous Pulmonary Cavitation Tending to Heal Spontaneously. Lasar Dunner. Brit. J. Radiol. **17:** 274–277, September 1944.

This report is based on the observation of 16 tuberculous patients ranging in age from fifteen to thirty-two. Each presented a circular, thin-walled cavity with no translucency, associated with a miliary type of spread. Tubercle bacilli were found in the sputum in every case. Physical signs were slight or absent. The symptoms were those of early pulmonary tuberculosis. The cavities all disappeared, sometimes faster, sometimes slower, than the other infiltrations, in periods varying from nine to thirty-six months. Since none of these patients had received any of the usual therapeutic measures, as artificial pneumothorax, phrenic avulsion, etc., the author suggests that a conservative attitude should be adopted in cases manifesting this "cavitation complex." SYDNEY J. HAWLEY, M.D.

Bronchocolic Fistula. Russell Buxton and Rachelle L. Kurman. Am. J. Surg. **67:** 137–139, January 1945.

This case is the second of bronchocolic fistula to be recorded. A 9-year-old colored boy was admitted to the hospital with a diagnosis of gangrenous appendix with perforation. He was operated on immediately and the diagnosis was proved to be correct. His postoperative course was one of infection with elevation of temperature and severe secondary anemia. On the twenty-eighth postoperative day the temperature rose to 105°, with coughing, spitting, and vomiting of a bloody purulent material. Roentgen examination showed consolidation of the base of the right lung. On the sixtieth postoperative day one ounce of 1 per cent mercurochrome was injected into the draining abdominal sinus and for twenty minutes the patient spit up mercurochrome-tinged sputum. A fistulous tract connecting the right lower quadrant opening with the lung seemed probable. Skiodan was injected into the appendiceal fistula and a film revealed a sinus tract which

could be traced upward behind the liver, extending through the diaphragm into a bronchus in the right lung. The patient was discharged with the fistula still draining. Nine months later he had apparently recovered except for a slight cough, and two years later he was reported to be completely normal. A roentgenogram is reproduced.

Radiological Diagnosis of Myocardial Infarction. David R. Cameron and Peter J. Kerley. Lancet **1:** 52–53, January 13, 1945.

Recent studies have suggested that myocardial infarction can now be diagnosed accurately by fluoroscopy in a high proportion of cases. Master (J. Mt. Sinai Hosp. **6:** 18, 1939) describes a local diminution, absence, or reversal of movement of the left ventricular silhouette in the infarcted area; he found one or other of these changes in 66 out of 100 cases of infarction. The abnormal pulsation was commonly noticed in the apical or supra-apical portion of the left ventricular outline. Master considered that the abnormality, if visible in the postero-anterior view, represented an anterior or posterior infarct, while if it was seen in the left oblique or lateral view, it represented a posterior infarct. Levene and Lowman (Radiology **36:** 159, 1941), in addition to alteration in pulsation, describe a loss of convexity of the left cardiac border in typical cases of infarction.

In order to determine the value of fluoroscopy in the diagnosis of infarction, 27 patients with certain or probable myocardial infarcts and 10 controls were examined, with the patient's history and electrocardiographic findings unknown to the roentgenologist. Since the patients were ushered one after another into a darkened room, it was not possible for the examiner to be biased by their facies or apparent age.

The left ventricular border was examined in the postero-anterior view or with slight rotation to the left, and again in the left anterior oblique or in such an approximation to it as would insure the clearest view. No account was taken of an altered heart shape, but diminution, reversal, or absence of pulsation was noted. If one of these was seen in the postero-anterior view, an anterior infarct was assumed; if in the left oblique, a posterior infarct. No more accurate localization than this was attempted. It was later realized that the left oblique view was not the best in which to look for a posterior infarct, for this lesion is apparent as often as not in postero-anterior films. In addition, the greater amplitude of movement normally seen in the left oblique position makes it more difficult to detect local changes. In both views the apical and supra-apical regions were particularly observed.

Results of this study in 14 patients with positive clinical evidence of infarction, confirmed by electrocardiography, with localization of the site, show that fluoroscopic diagnosis of anterior infarction is accurate, but that both the site and occurrence of a posterior infarct are more difficult to define.

Six patients had a history of infarct, with electrocardiograms showing either auricular fibrillation or bundle branch block. Deductions as to the reliability of fluoroscopy cannot be made on such a small number of patients, but it is obvious that accurate x-ray diagnosis would be of great value in obscure cases of fibrillation due to infarction.

The findings in a group of 7 patients in whom either the history or the electrocardiogram was equivocal again show that roentgen diagnosis is more reliable in anterior lesions, which, in any case, are more likely to show convincing electrocardiographic findings. It is clear, however, that fluoroscopy can be of great value in cases of infarction masquerading as dyspepsia or a biliary attack.

In the fourth group, consisting of 6 patients with cardiac abnormalities other than infarction and 4 normal persons, an anterior infarct was diagnosed in one case with a slight left ventricular enlargement, but no clinical or electrocardiographic suggestion of infarct.

This study seems to show that anterior infarction can be diagnosed and localized accurately by fluoroscopy. The alterations in the movements of the heart are probably contributed to by a thickened or adherent pericardium at the site of infarct. The authors conclude that it is probably wrong to look for signs of a posterior infarct in the left anterior oblique position.

Preoperative Diagnosis of Patent Ductus Arteriosus. M. J. Shapiro. J. A. M. A. **126:** 934–937, Dec. 9, 1944.

Clinical findings in 62 patients with patent ductus arteriosus are presented and the importance of a correct preoperative diagnosis is stressed. The diagnostic criteria are listed as follows: (1) machinery murmur, (2) thrill in the pulmonary area, (3) enlarged pulmonary artery, (4) enlarged, pulsating pulmonary vessels, (5) enlarged heart, (6) increased pulse pressure, (7) stunting of growth, (8) absence of cyanosis or clubbing of the fingers, (9) normal electrocardiogram, (10) history of cardiac lesion from birth.

Fluoroscopic and roentgenographic examinations are of considerable value as aids in diagnosis, as well as in following the progress of the individual case.

The author feels that a great deal can be learned by x-ray methods in regard to the severity of the leak and the amount of cardiac strain. Differential diagnosis from other types of heart disease and from the so-called venous hum is considered. It is suggested that no case be treated surgically unless the findings are characteristic.

MARVIN J. SHAPIRO, M.D.
(University of Michigan)

Right Retroperitoneal Diaphragmatic Hernia. N. R. Barrett. Brit. J. Surg. **32:** 421–425, January 1945.

Roentgen examination of the thorax in a man of 52 complaining of abdominal pain and dyspnea on exertion revealed an opacity at the base of the right chest which merged with the shadow of the diaphragm and liver below, with a definite upper margin extending transversely across the lower third of the right lung field. Later x-ray studies, following a diagnostic pneumothorax, showed the mass to be extrapulmonary, posterior to the pleural cavity, and separate from the chest wall. It was lobulated and contained areas of different density. A barium meal examination showed some deformity of the duodenal cap but nothing else of significance.

The diagnoses considered were diaphragmatic hernia, tumor of the chest wall, and tumor of the diaphragm. The possibility of hernia was rejected because no part of the intestinal tract was demonstrable in the thorax, the fact that solid viscera can pass into the chest without being accompanied by intestine being entirely disregarded. The other two diagnoses having been eliminated, a thoracotomy was advised. At this time the patient volunteered the information, for the first time,

that he had been stabbed in the back by a narrow-bladed knife twenty-six years previously, and a small scar was discovered over the right tenth rib, 3 inches from the mid-line.

At operation the mass was found on the upper aspect of the diaphragm, as demonstrated radiologically. It proved to be a retroperitoneal diaphragmatic hernia containing the right kidney surrounded by perinephric fat. There was no hernial sac; the aperture in the diaphragm was 3 1/2 inches long. The patient made a complete recovery.

Diaphragmatic hernia is more common on the left side. The explanation of this varies with the type of hernia. In cases due to congenital malformation of the diaphragm, the defect occurs about the eighth week of intra-uterine life, at which time the pleuroperitoneal canal on the right will presumably be closed, while closure of the corresponding canal on the left is likely still to be incomplete. A left-sided lesion is also favored by the fact that at this stage of development, the liver is entirely right-sided, the stomach has reached its adult position below the diaphragm, and the left lung is smaller than the right. Thus it is not only easier for a left-sided hernia to occur, but there is more space in which it can be accommodated. The author believes that left-sided para-esophageal hernia is the commoner variety because the hiatus lies to the left of the mid-line and the stomach and spleen, which are the usual contents of the hernia, are on the left. The chance of traumatic perforation of the diaphragm is equal upon the two sides of the body, but the risk of subsequent hernia is greater upon the left because the liver seals the gap with greater certainty than does the stomach, spleen, or colon.

The importance of hernia due to small penetrating wounds of the diaphragm lies in the fact that there are no signs or symptoms until the hernia has attained considerable size. In the performance of thoracotomies for chest wounds, the author has observed perforations of the diaphragm which were soon sealed by a small plug of omentum, but while this may cure the condition, it may also act as the apex of a hernia, more and more of the abdominal contents being forced into the pleural cavity over a long period of time. This accounts for large diaphragmatic hernias discovered only after a lapse of many years following injury.

The diagnosis of hernia is generally based on demonstration of some part of the gastro-intestinal tract in the thorax, but the fact that solid viscera, as the kidney, liver, or spleen, may be the only ones to pass through the opening should not be overlooked.

MAX CLIMAN, M.D.

Congenital Diaphragmatic Hernia. Visceral Strangulation Complicating Delivery. J. W. Thompson and Leo J. LeBlanc. Am. J. Surg. **67:** 123–130, January 1945.

A case of congenital diaphragmatic hernia complicating the puerperium [rather than delivery] is presented.

The first pregnancy, labor, and puerperium of this patient, a 31-year-old white woman, had been without incident. About five hours after the spontaneous delivery of her second child, the patient complained of severe epigastric pain and was very restless. She became nauseated and vomited several times. Respirations were labored and accelerated. There was mild cyanosis and the patient appeared alarmingly ill. Administration of oxygen per nasal tube was begun. Examination of the chest revealed a splinted left thorax. The lower two-thirds of the chest were dull to percussion, and no breath sounds were audible on this side. The heart sounds were best heard well within the midclavicular line; there was possible cardiac dullness to percussion to the right of the sternum. The right chest was resonant to percussion and the breath sounds were normal. The abdomen showed the usual postpartum contour, moderate distention, and generalized tenderness. A mass, which was thought to be an enlarged spleen could be palpated in the left upper quadrant.

Roentgenograms of the chest and abdomen, taken in the patient's room revealed increased density throughout the entire left lung field. The heart and mediastinal structures were shifted to the right. There was a distinct irregularity of the left diaphragm. The stomach, well outlined by entrapped air, was displaced into the left thorax. The tip of the indwelling nasal tube was in the stomach. A diagnosis of left-sided diaphragmatic hernia with progressive strangulation of the hernial contents was made and exploration was carried out.

A large congenital diaphragmatic hernia, through which all of the hollow viscera of the abdomen had migrated into the left thorax was found. The mesenteries of the stomach and intestines were elongated and there had been a complete counterclockwise rotation, causing torsion of the pancreas, which was acutely inflamed and covered by a fibrino-plastic exudate with numerous areas characteristic of superficial fat necrosis. The only organs remaining in the abdomen were the spleen, which was enlarged to about twice its normal size, the liver, which was also enlarged and extended three or four fingerbreadths below the costal margin, and the descending colon. The viscera were easily replaced within the abdominal cavity and the hernia repaired. On the eleventh postoperative day, roentgenograms of the chest showed an almost complete collapse of the left lung with an extensive pneumothorax of the same side. There was a marked depression of the left diaphragm. No fluid level could be seen. The patient was discharged from the hospital on her thirteenth postoperative day in excellent condition. The breath sounds and percussion notes gradually became normal, and a chest film about two and a half months following delivery showed that the left lung had completely expanded except at the costophrenic angle. Roentgen studies of the thorax and gastro-intestinal tract at this time revealed a low-lying, atonic stomach situated below the left leaf of the diaphragm. The motion of the diaphragm might possibly be considered slightly restricted. The colon was redundant and atonic. That the mesenteries were still abnormally elongated could be demonstrated by the ease with which the barium-filled viscera could be manipulated to distant corners of the abdominal cavity.

Diaphragmatic hernia is not a common complication of pregnancy. Four fatal cases diagnosed during pregnancy have been reported. Two cases of diaphragmatic hernia complicating the immediate puerperium, treated by conservative measures, without fatality, are all that the literature supplies. The authors' case is believed to be the first one in which the patient was operated upon with a successful result. In order that such congenital anomalies may be recognized, and appropriate treatment carried out, careful clinical and roentgen studies of the thoracic organs of pregnant women are of paramount importance.

THE DIGESTIVE SYSTEM

Melanoma of the Small Intestine. Peter A. Herbut and Willis E. Manges. Arch. Path. **39:** 22–27, January 1945.

Approximately 25 cases of melanoma of the small intestine have been recorded in the literature. In 9 of these the tumor was reported as primary in the small bowel, in 16 as metastatic. To the latter group the authors add 5 cases. In 3 of the cases the neoplasm originated in a cutaneous nevus, while in 2 the primary site was not determined. Abdominal pain, frequently with other symptoms of intestinal obstruction, was present in 18 of the 30 cases now on record, and intussusception occurred in 10.

The authors believe that melanoma of the small bowel is usually, if not always, metastatic, for melanoblasts have not been demonstrated in the small intestine and the involvement of the bowel in known secondary melanoma is the same as in cases in which the tumor is thought to be primary. Primary cutaneous growths may be lost sight of in the often delayed metastasis peculiar to melanoma. Occasionally quiescent moles give rise to local and distant metastases. Autopsies are often, of necessity, too limited to reveal the site of a possible primary growth.

Multiple Polypoid Disease of the Colon and Rectum. H. L. Pugh and J. P. Nesselrod. Ann. Surg. **121:** 88–99, January 1945.

Multiple polypoid disease of the colon, termed also polyposis, polypoidosis, and multiple adenomatosis, is a distinct entity and is to be distinguished from single or multiple polypi resulting from irritation or infection. Although multiple polypoid disease occurs infrequently, it is of great importance because it is attended by an extreme predisposition to malignant change. Patients with this condition are almost certain to die with cancer at an early age unless radical surgery is instituted promptly. Multiple polypoid disease is familial or inheritable, attacking both sexes and transmissible by both.

While proctosigmoidoscopic examination will reveal the presence of polypi in the majority of patients, a roentgen study of the colon should be carried out in each case. The importance of a contrast film following the injection of air after the barium has been evacuated cannot be overemphasized. Roentgenograms in the authors' two cases demonstrate the value of this procedure.

Radical surgical intervention, namely, total colectomy, is warranted and carries with it the only hope of permanent cure. Ileosigmoidostomy followed by resection of the intervening segment may be done in lieu of total colectomy in cases where the lesion in the rectum and rectosigmoid can be removed by fulguration. A case illustrating each of the surgical procedures is reported.

Roentgenologic Examination of Acute Appendicitis. Ragnar Steinert, Ingvard Hareide, and Thorolf Christiansen. Acta radiol. **24:** 13–37, Feb. 28, 1943. (In English.)

One hundred and four cases of acute appendicitis were observed roentgenologically and verified by operation. Examinations were made without contrast medium, with the patient supine and erect or, if he were unable to stand, in left lateral decubitus.

In 80 cases, the roentgen examination demonstrated deviations from the normal. Concretions in the appendix were visible in about 10 per cent, approximately one-third of those cases in which concretions were found at operation. In all cases with roentgenologically visible concretions, a gangrenous or perforated appendix was found at operation.

A local density lateral to the cecum may be due to a perforated appendicitis or to a small appendiceal abscess, but ordinary gangrenous, non-perforated appendicitis is also to be considered.

Acute appendicitis was not always characterized by gas accumulation in the cecum. Occasionally, the cecum is empty of gas.

Fluid levels in the cecum constituted a frequent and characteristic finding. They were also found in the small intestines, particularly in the terminal loops of the ileum.

Reduced excursion of the diaphragm on the right side was always observed in acute appendicitis. Obliteration of the right flank stripe was noted in cases of severe appendiceal inflammation and especially of perforation. Effacing of the right psoas shadow and left convex lumbar scoliosis could be seen in all grades of acute appendicitis.

Typical roentgen features of acute appendicitis may be seen four and a half hours after the onset of the attack. MAX SGALITZER, M.D.

Roentgenologic Examination of the Intrahepatic and Extrahepatic Biliary Tract (Cholangiography). Aguinaldo Lins. Rev. med. Panamericana **1:** 185–193, August–December 1944.

The author reviews the subject of cholangiography since 1915, giving several excellent illustrations covering the method, considered just as important to the surgeon as is electrocardiography to the cardiologist. The advantage of making cholangiographic examinations during operation is stressed in cases of inflammation involving the sphincter of Oddi, in stenosing pancreatitis, and choledocholithiasis. Barium sulfate, lipiodol, iodochloral, and Hippuran are the contrast media of choice. The author believes that refinements of the Graham-Cole technic may reduce cholangiograms in the future. In conclusion, he compares the examination of the biliary tree to that of the urinary tract. SEBASTIAO V. FRANCO, M.D.

Spontaneous Internal Biliary Fistulae. W. H. Beekhuis. Acta radiol. **24:** 38–44, Feb. 28, 1943. (In German.)

The author reports a case of spontaneous internal biliary fistula due to perforation of a duodenal ulcer into the common bile duct. The diagnosis was made roentgenologically and was verified at operation.

MAX SGALITZER, M.D.

THE SPLEEN

Radiological Estimation of Splenic Enlargement in Malignant Tertian Malaria. W. H. T. Shepherd. Brit. J. Radiol. **17:** 280–285, September 1944.

This report is the outcome of a study conducted in an overseas area where malignant tertian malaria is hyperendemic. Its author was with the British R.A.F.

The spleen is examined with the patient prone and rotated approximately 10° to the left. With bed patients preparation is advisable; in others it is usually not necessary. For the average patient the factors are: 80 kv. and 80 ma. sec.; medium speed intensifying screens and Potter-Bucky diaphragm; anode film distance 36 inches.

The radiographic splenic index is the product of the length by the breadth in inches. Any index below 8 is regarded as normal. Between 8 and 12 is regarded as 1-plus enlargement; above 12 as 2-plus enlargement.

Of 19 cases of malignant tertian malaria studied radiographically on admission, 8 showed an index above 8. Of 10 cases of clinical malaria, 6 showed a raised index. Four of 8 patients with other disease (regional ileitis, non-specific enteritis, staphylococcus folliculitis, and vaccinia) showed a raised index. The patient with regional ileitis had had two previous attacks of malaria.

Radiography is more accurate than palpation in detecting an enlarged spleen. The spleen is not palpable until the index reaches 9 1/2.

SYDNEY J. HAWLEY, M.D.

Roentgenologic Examination of the Abdomen as an Aid in the Early Diagnosis of Splenic Injury. James F. O'Neill and J. P. Rousseau. Ann. Surg. **121:** 111–119, January 1945.

Damage to the spleen is probably the most common serious intra-abdominal injury resulting from blunt force. Clinically, three types of injury may occur: (1) extensive rupture with immediate massive hemorrhage, (2) small lacerations which ooze blood slowly over a period of hours or possibly days, and (3) delayed rupture. When the injury to the spleen is of the first type, the diagnosis is usually made easily and splenectomy is carried out. Injuries of the second and third types are difficult to diagnose in the hours immediately following trauma, especially in the presence of associated injuries. The symptoms and signs may disappear completely or so improve that the patient may be allowed to resume full activity. Then, after a latent period of hours, days, or even months, secondary hemorrhage may occur, usually of such severity that circulatory failure promptly ensues.

The time to remove a slowly bleeding spleen is early, before blood loss threatens life. Diagnosis must, therefore, be made early. Clinical symptoms and signs may be equivocal. Hematologic studies may or may not be of aid. Abdominal aspiration or peritoneoscopy have been advocated, but these examinations are more difficult and more dangerous than the taking of a plain film of the abdomen. The latter can be of great assistance in establishing early the diagnosis of a lacerated spleen. Solis-Cohen and Levine (Radiology **39:** 707, 1942) on roentgen examination of the abdomen in three cases, observed an obliteration of the splenic shadow and a dilated stomach, with serration of the greater curvature. In each case the diagnosis of splenic damage was confirmed at celiotomy. In plain films of the abdomen of 100 patients with no demonstrable splenic lesions these findings were not encountered.

The authors studied 3 patients with non-penetrating trauma to the left upper quadrant, left flank, and left lower thorax. One of these patients had a lacerated spleen and two fractured ribs, with no evidence of any other lesion; the plain film of the abdomen demonstrated very clearly the signs described by Solis-Cohen and Levine. The roentgen findings in the second patient, who had a laceration of the spleen as well as damage to the left kidney, were also characteristic. In both these cases the appearance of the curvature became normal following operation. In the third patient, with a shattered kidney and a normal spleen, the greater curvature was smooth and the stomach contained much gas; the left kidney shadow was obliterated and the left psoas shadow obscure.

These observations corroborate those of Solis-Cohen and Levine. It is evident that the gas-containing stomach, with the serrated greater curvature, will show on a plain film of the abdomen when the splenic laceration is small or moderately large. These findings still occur when some other viscus in addition to the spleen is injured, but are absent when the kidney is ruptured in the presence of a normal spleen and following splenectomy.

Further experience with these roentgen criteria for damage to the spleen is necessary. The importance of plain films of the abdomen and chest when splenic damage is suspected is stressed, not alone to help evaluate the injury to the spleen, but to determine possible associated thoracic injuries.

THE SKELETAL SYSTEM

Plasticity of Bone. James F. Brailsford. Brit. J. Surg. **32:** 345–357, January 1945.

This paper is the Hunterian Lecture delivered at the Royal College of Surgeons of England on April 26, 1944. Beginning with two brief quotations from a lecture by John Hunter on "Diseases of Bones and Joints," which dealt with rickets and pointed out how the plasticity of bone may produce various deformities of the spine, pelvis, hip, etc., the author reviews the histology and embryology of normal bone. Prior to the deposition of mineral matter, the pre-osseous tissue, or matrix, is plastic and can be compressed and deformed by stresses and strains, the final effect of which will depend upon their duration, the changes wrought in surrounding structures and their shape and position at the time setting of the matrix takes place. With the deposition of crystalline salts of calcium, such as we see in calcification, no material contribution is made to the rigidity and strength of bone, as is demonstrated in fetal osteogenesis imperfecta and in one stage of avascular necrosis of bone. With the incorporation of colloidal calcophosphate mineral matter, the pre-osseous matrix undergoes a rapid setting and the bone acquires a rigidity, resilience, and a related fixation of form which is not altered by normal function. Normal ossification, beginning in an ossific nucleus, spreads uniformly and gradually from the regular center to the periphery of the cartilaginous mass. It is not deformed by the normal stresses and strains of the growing child.

If, however, ossification in any site is irregular and multiple irregular ossific centers develop throughout the cartilaginous structure, the latter will not withstand normal function. Due to irregular deposition of mineral matter it loses its elasticity and becomes plastic and therefore liable to compression and deformity. Examples of this can be seen in hypothyroidism, in the form of spinal deformities with irregular ossification of vertebral bodies and, in older children, changes in the

femoral capital epiphysis resembling a healed Legg-Perthes' disease.

In cases of paralysis there is a gradual decalcification of bones of the affected part. Scoliosis of the spine in children following one of the exanthemata is progressive, possibly due to weakness of spinal musculature.

Plasticity due to generalized changes in bone is represented by osteogenesis imperfecta, with deformities dependent on gravitational and muscular pulls; the active phase of infantile rickets and renal rickets, especially when associated with hyperparathyroidism; and the skeletal changes in hyperparathyroidism associated with a parathyroid tumor.

The most notable example of plasticity limited originally to one bone is Paget's disease, or osteitis deformans. This condition may begin in one bone or in widely separated bones. The radiographic appearance may exhibit three distinct types of bone changes: (1) osteoporotic, (2) osteolithic, (3) lithocystic. The first type shows general expansion of bone, osteoporosis, coarse trabeculations, and bending under normal strains. Fractures may occur. The concave aspect is condensed while the convex aspect shows one or more incomplete fractures from periphery to the center. The osteolithic bone is much denser than normal and is abnormally fragile and easily fractured. This type simulates metastatic carcinoma. In the lithocystic form the bones eventually show massive development with thickening of the dense cortex, within which cyst-like areas of various size occur.

Polyostotic fibrous dysplasia is another condition which produces plasticity of bone locally or throughout the skeleton, resulting in great deformity. The lesions are cystic in appearance, occurring in long bones and skull. There is no general decalcification and the unaffected parts of the skeleton show normal cancellous and compact tissue.

Among characteristic changes in various skeletal elements exhibiting abnormal plasticity, the author lists basilar impression, scoliosis and kyphosis, spondylolisthesis, and protrusio acetabuli.

Localized plasticity of bone may also be due to trauma. This is seen more commonly in the spine, particularly in young persons in whom ossification is incomplete, engaged in occupations requiring continuous bending. Compression is exerted on the anterior aspects of the dorsal vertebral bodies; reactive inflammatory changes may be induced in the tissues under compression, and localized decalcification with plasticity results. Later re-ossification fixes the deformity. Continued pressure leads to condensation of the opposing bony surfaces and ossification of the adjacent ligaments. Any lesion, whether it be developmental, traumatic, inflammatory, or neoplastic in origin, which alters the normal alignment or balance of the skeleton, will cause abnormal strains to be placed on some structure and sooner or later this will show the reactive changes similar to those described in the spine.

In osteochondritis the affected bone is plastic and can be deformed by pressure from adjacent bones. In Legg-Perthes' disease (osteochondritis deformans juvenilis) of the femoral capital epiphysis the bone exhibits abnormal plasticity for three to four years. In the infant scaphoid and the vertebral body the time is speeded up and within a year or a year and a half the affected bone has been sufficiently reconstituted to permit of normal function.

Trauma has been suggested as an etiologic factor in the localized lesions of osteochondritis. Undoubtedly trauma can produce avascular necrosis of bone. It is seen more commonly following fracture of the femoral neck or carpal scaphoid, and the most important feature is that the necrotic fragments excite inflammatory reactive changes in the adjacent vascular bone, leading to its decalcification and abnormal plasticity, until the necrotic bone has been removed or entirely reconstituted.

In fractures of the neck of the femur with fragments held in position by a Smith-Petersen pin or any other metal nail, there may be radiographic evidence of good alignment and some union after a fairly long interval. If weight-bearing is permitted at this stage and there is a certain amount of pain accompanying the use of the limb, one should be careful to exclude avascular necrosis. Otherwise, the pin will go through the plastic bone of the femoral head or neck. In a previous paper the author had pointed out that unless a patient can submit to immobilization until radiographs show reconstitution of the fragment, it should be removed as soon as it is detected. MAX CLIMAN, M.D.

Osteoid Osteoma. Samuel Kleinberg. Am. J. Surg. **66:** 396–401, December 1944.

Osteoid osteoma is a lesion which can usually be readily diagnosed. At times, however, its identification may present difficulties, particularly if it is so located that it does not permit accurate roentgenographic visualization or if there is an associated tissue reaction which simulates another disease.

Clinically osteoid osteoma has a triad of significant features which should suggest its presence. The first of these is localized pain, usually in an extremity, gradual in onset and later becoming persistent and continuous. The greatest intensity of the pain is always in the same location and is characteristically limited to a comparatively small area which may be surrounded by a large surface with less severe pain. Second, if the area of the lesion is accessible to physical examination, and it usually is, there is tenderness to pressure in the region of the most intense pain. Third, the roentgenogram exhibits a small round or oval rarefaction of bone at the approximate site of the pain and tenderness. The rarefied area is surrounded by a zone of sclerosis which may appear as a narrow ring or may extend for several inches beyond the central focus. These symptoms and roentgen changes are not accompanied by any systemic disturbances, and the customary laboratory tests are negative.

Three cases of osteoid osteoma are reported. The first was a typical case involving the upper metaphysis of the fibula. In the second case a diagnosis of osteodi osteoma was not made preoperatively. This patient, a ten-year-old girl, had been treated for about a year for backache, which had been attributed in turn to strain, scoliosis, and osteochondritis of the spine. Lateral roentgenograms finally showed a slight kyphos at the level of the first and second lumbar vertebrae with diminution in the size of the intervertebral disk between these vertebrae, and a diagnosis of possible early Pott's disease was entertained. When first seen by the author, the patient complained of severe pain in her back only in the region of the first and second lumbar vertebrae. In that location there was tenderness to pressure on the right side of the spinous process and nowhere else. A mild left lumbar scoliosis was present. Roentgenograms taken at this time, as well as earlier

films, showed an excavation in and absorption of part of the right lamina of the second lumbar vertebra, which had previously been overlooked. Believing that there was probably a neoplasm which was eroding the lamina, the author advised an exploratory operation. This revealed a red, granular mass the size of a cherry between the laminae of the first and second lumbar vertebrae on the right side with erosion of a part of the lamina of the second lumbar vertebra. The mass was removed and a hemilaminectomy on the first and second lumbar vertebrae was performed to allow inspection of the dura. The pathological diagnosis was osteoid osteoma. The patient was completely relieved of her backache and at the time of the report was rapidly regaining full function of the spine.

The third case, in point of difficulty in differential diagnosis, lies between the two previous cases. The osteoid in this case involved the neck of the astragalus. In the early stages of the disease there was such a marked swelling of the ankle extending up along the heel cord that a diagnosis of tuberculous arthritis was suggested. Immobilization gave no relief, and an arthrotomy did not disclose the real pathological process. The persistence of the greatest pain and tenderness in the anterior portion of the ankle in the region of the astragalus and the eventual appearance of a localized rarefaction in the neck of the astragalus led to the correct diagnosis and a surgical cure.

Roentgenograms are reproduced.

Differential Diagnosis of Ewing's Sarcoma: Contribution to the Knowledge of Primary Reticulum-Cell Sarcoma of Bone and So-Called Eosinophilic Granuloma. C. G. Ahlström and S. Welin. Acta radiol. **24:** 67–81, Feb. 28, 1943. (In German.)

A case of primary reticulum-cell sarcoma of the bone and one of eosinophilic granuloma of the skeleton are reported. The roentgen differentiation of these conditions from Ewing's sarcoma may be difficult, requiring supplementary anatomic and clinical examinations. In connection with these two cases, the authors deal with the anatomic, roentgenologic, and clinical picture of the primary reticulum-cell sarcoma and of eosinophilic granuloma. The relation between the latter and Schüller-Christian disease is stressed.

MAX SGALITZER, M.D.

Syndrome of Precocious Puberty, Fibrocystic Bone Disease and Pigmentation of the Skin: Eleven Years' Observation of a Case. Bernard M. Scholder. Ann. Int. Med. **22:** 105–118, January 1945.

The author's patient, a girl of nineteen at the time of this report, had been under his observation since the age of eight. She gave a history of vaginal bleeding, more or less irregular, since the age of three. Prominence of the breasts was observed in the fifth and pubic hair in the sixth year. A fracture of the humerus was sustained at the age of six, and abnormalities of the bone structure were discovered at that time.

At nine years of age, roentgen studies demonstrated multiple areas of bone absorption in the left upper and lower extremities and left ilium. The right side of the skull showed bone condensation at the base and about the right orbit. A biopsy specimen from the left humerus revealed fibrous osteitis. Calcium and phosphorus determinations were within normal limits. Studies of sex hormone in the urine disclosed an increase over the amount normally found at this age. The conclusion reached at this time was that the patient had a "complicated endocrine disease, involving the parathyroid, suprarenal cortex, and ovarian-pituitary functions." An intravenous pyelogram failed to reveal any evidence of a tumor of the adrenal cortex.

At the age of twelve the patient was given a course of injections of antuitrin-S, in order to stimulate maturation of the ovarian follicles and thus establish a more regular menstrual cycle. Roentgenograms at this time showed (1) involvement of right side of skull and left side of the torso and extremities; (2) bone condensation in the skull and bone absorption in the trunk and extremities; (3) early maturation of the skeleton, *i.e.*, closure of the epiphyses.

Intellectually the patient developed satisfactorily, her scholastic attainments being of the highest order. At the age of nineteen the most obvious external abnormalities were a slight limp, shortness of stature (61.5 in.), and facial asymmetry due to prominence of the right frontal and maxillary bones. An area of yellowish-brown pigmentation, about 4 cm. in diameter, was present over the left lumbosacral joint.

Eighteen cases similar to the one reported have been collected from the literature and are presented in tabular form. No anatomic basis for the syndrome has been demonstrated, either on surgical exploration or at autopsy. The author's assumption is that the underlying cause is a hypothalamic (pituitary)-parathyroid disturbance. Normally, at puberty the pituitary appears to be released from certain inhibiting factors, presumably through the action of the hypothalamus, and to become active, with consequent rapid bodily growth and development of sex characteristics. A premature release from these restraining factors would seem to be a reasonable explanation for the precocious puberty in the cases under discussion. What initiates this early release is not entirely clear, but cranial injuries, intracranial tumors, and encephalitis have been observed as precursors of the syndrome. In the author's case there was a history of difficult birth, and it is suggested that some injury may have occurred at that time which affected the hypothalamic region sufficiently to disturb normal control over the pituitary. As to the skeletal changes, osteitis fibrosa cystica has been produced experimentally by a long continued excess of estrogen, probably acting through the parathyroids. That there is an excess of estrogen in the cases under discussion is obvious from the precocious puberal changes.

STEPHEN N. TAGER, M.D.

Roentgenographic Interpretation of What Constitutes Adequate Reduction of Femoral Neck Fractures. Robert T. McElvenny. Surg., Gynec. & Obst. **80:** 97–106, January 1945.

The author suggests standardization of what constitutes adequate reduction of intracapsular femoral neck fractures. His suggestions are the result of a six-year period of study of both successful and unsuccessful cases and their respective roentgenograms. No particular technic is advocated for internal fixation of an intracapsular fracture of the femur, but the author has found the cannulated Smith-Petersen nail particularly satisfactory because of the success achieved with it. An excellent result is considered one with (*a*) no pain or spasm, (*b*) no limp, (*c*) equal leg length, (*d*) complete range of active hip motion including full internal ro-

tation, (*e*) no need of external aid for walking and climbing. On roentgenographic examination, the neck is practically of normal length, the head is smooth with normal density, the joint space is maintained, and the fracture has healed, with unbroken lines of trabeculation crossing the fracture site.

The method described for obtaining reduction of femoral neck fractures is based on complete relaxation under an anesthetic and consists of pulling the limb down in external rotation and slight abduction. While traction is maintained, gentle flexion and moving of the hip are carried out until the neck passes the head. The limb is then internally rotated to its limit, and no resistance should be encountered in performing this maneuver. The patella should face directly medially and the internal femoral condyle should be directly on a small sandbag which supports the knee. When this position is attained, the limb is adducted to neutral or slightly beyond. An anteroposterior and, if desired, a lateral roentgenogram are then taken.

If, in the anteroposterior view, the criteria are satisfied, a guide is inserted, a guide wire is put in and then anteroposterior and lateral views are taken. If the wire is centered perfectly and the hip is reduced perfectly in both views, the nail is driven home. The fluoroscope is used to introduce the guide and all checking is done by the operator by means of roentgenograms. The judging of the depth of the guide wire and nail is done by the fluoroscopist and checked again by the operator by means of roentgenograms.

Anteroposterior and lateral roentgenograms check both the depth and position of the nail and the reduction. If these are satisfactory, the guide and guide wire are withdrawn and the wound is closed.

The reduction is applicable to the operating room, the author has found, and a flat wooden table with a cassette box under its top proves as satisfactory as any table. Also he has found that the Soutter apparatus has been most satisfactory as a method of applying traction.

All the standards described in this paper are based on roentgenograms taken with the limb in full internal rotation. In this way the length of the femoral neck is established. Roentgenograms which are presented show that the head and neck are separate from one another and that there are no overlapping shadows where a portion of the neck covers a portion of the head. If overlap is present, it means that complete reduction has not been attained, because if complete internal rotation be present, any overlap indicates overriding or angulation, but not end-to-end contact. Any x-ray view short of complete internal rotation distorts the relationship of the head and neck and makes interpretation of the film practically worthless.

A satisfactory reduction is one in which the limb is in complete internal rotation and at least neutral lateral position. The neck fragment should be well under and well inside the head fragment as shown in the anteroposterior view. In the lateral view, the head and neck should be in line with no angulation and no overlap. The fracture surfaces should appose one another.

A satisfactory fixation is one in which the fixation material enters the shaft of the femur at or below the level of the lesser trochanter, runs through the lower half of the neck parallel to the calcar femorale, and centers the head in both planes. The main purpose of the fixation, according to the author, is to act as a guide which allows the head to settle on the neck in a position in which the weight thrust is directly applied to the fracture site without shearing or torsion forces being exerted on the fixation material. The position that the femoral head and neck should assume to gain this objective is one with the neck fragment well under and well inside the head fragment as shown in the anteroposterior view.

The author had 4 failures in 38 consecutive cases of subcapital or transcervical fractures. The failures occurred in hips which were imperfectly reduced; that is, the neck fragment was not placed well under and well inside the head fragment. The failures were due to many factors, as inability to obtain correct traction, inability to obtain adequate lateral roentgenograms, poor anesthesia, personal carelessness, and occasional inability to obtain satisfactory reduction of the hip under ideal conditions.

The author believes that, if a hip cannot be reduced or if there is doubt as to the effectiveness of reduction, either an immediate intertrochanteric or subtrochanteric osteotomy should be performed, as the case may require. Also, if a hip be fixed but is not doing well, an osteotomy should be done at the first signs of failure. Such a plan, he believes, might reduce the amount of disability now following intracapsular fractures of the femoral neck.

R. E. BOOTH, M.D.

Slipping of the Upper Femoral Epiphysis: Diagnostic and Therapeutic Considerations. William T. Green. Arch. Surg. **50:** 19–32, January 1945.

If slipping of the upper femoral epiphysis is detected early, the prognosis should be excellent, but if marked displacement occurs, there may be severe crippling in spite of treatment. This report deals with 26 cases, 10 bilateral, in children from 7 to 14 years old. In 28 hips the results are known, 2 were not treated, and 6 were treated too recently for evaluation. Limitation of internal rotation is the earliest physical sign; limitation of flexion and abduction, pain, muscle spasm, and limp appear later. The hip may be capable of hyperextension.

A meticulous roentgen examination is necessary for early diagnosis. Studies must include a lateral projection (the author prefers a "frog" projection). The earliest finding is rarefaction of the neck adjacent to the epiphyseal line and minimal anterior displacement of the head; this can be seen only in a lateral view. If the first examination is normal, suggestive clinical findings should lead to repetition at short intervals. More marked displacements are readily recognized; there may be callus formation at the angle between the head and the neck.

Early cases are best treated by a combination of traction and plaster fixation; nailing *in situ* without arthrotomy gave almost as good results. Cases with severe displacement did best following arthrotomy with resection of a small section of the neck (to preserve without tension the posterior capsule for its blood supply) with subsequent reposition of the head and nailing. Closed manipulation led to poor results.

LEWIS G. JACOBS, M.D.

Brachial Pain from Herniation of Cervical Intervertebral Disc. F. A. Elliott and Michael Kremer. Lancet **1:** 4–8, Jan. 6, 1945.

Eight cases of brachial pain are presented. In these cases there was a uniform distribution of pain in the

back of the shoulder, down the back of the arm and the radial border of the forearm, and sometimes in the upper pectoral region. There were paresthesias in the thumb, index, and middle fingers. In some cases there was a history of acute stiff neck. Findings included limitation of movement of the neck, pain in the arm produced by movements of the neck and by downward pressure on the head, and tenderness, weakness, and wasting of the upper fibers of the pectoralis major, triceps, and extensors of the wrist and fingers. The triceps was reduced or absent, usually with hypalgesia on the thumb and index finger. The clinical picture was that of a lesion of the 7th cervical root.

Roentgenograms may be normal. There may be a reduction of the normal cervical lordosis, narrowing of the 6th cervical disk, narrowing with sclerosis of the margins of the adjacent vertebrae, narrowing with anterior lipping, and narrowing with lipping in the region of the intervertebral foramen. The last finding is probably important, inasmuch as the foramen is narrower from side to side than from above down, and any further reduction of its width by a protrusion of the disk will compress the emerging root. Lipping is best seen in the oblique views. Changes such as these are, however, at most suggestive, as they are common in persons without symptoms. More accurate information is derived from contrast myelography. Pantopaque is used for this purpose because its fluidity enables it constantly to fill small spaces like the dural sleeve and it can be removed by a lumbar puncture needle with relative ease when the examination is complete. In 3 cases in which myelography was done, a filling defect was demonstrated opposite the 6th cervical disk on the affected side and—more important—the dural sleeve surrounding the root did not fill, in contrast to good filling of the unaffected roots above and below. This obliteration of the root sac confirms the presence of a pathological process and, in conjunction with a filling defect or notch in the column of pantopaque, suggests that non-filling is due to a herniation of the disk at that level.

In none of the authors' cases was surgery considered necessary, the pain being relieved by keeping the neck at rest.

Clothespin Graft of the Spine for Spondylolisthesis and Laminal Defects. David M. Bosworth. Am. J. Surg. **67:** 61–67, January 1945.

Of 77 bone grafts of the spine which have been performed at St. Luke's Hospital, New York, 11 were for spondylolisthesis, 32 for posterior herniation of the intervertebral disk, 8 for laceration of the intervertebral disk without posterior protrusion (including 2 probable cases of tuberculosis), 20 for lumbosacral strain (associated Schmorl's nodes and dural adhesions included), 1 for spinal cord tumor, 3 for old extensive laminectomy defects, and 2 for pseudarthrosis of previous spine fusion. The grafts included 66 of the double-clothespin and 8 of the single-clothespin type, 2 angulated strut grafts, and 1 inclusion graft. In the clothespin or "H" graft, which was devised by the author to overcome the structural weakness of the inclusion graft, the ends are notched to receive the spinous processes at either end of the fusion area. The graft is placed with the patient in flexion and the spinous processes separated. When the patient is extended, the graft is maintained firmly in position. Tibial bone was used at first for graft substance, but later massive iliac bone grafts were adopted.

In only 55 cases in this series had a sufficient time elapsed since operation to permit determination of solidity of the spinal fusion. Although the author feels that clinical estimation of solidity is unsatisfactory, he states that 49 of these cases (89 per cent) were believed to be solid. Four cases were known to be clinical failures. The only accurate method of determining solid spinal fusion is by flexion and extension roentgenograms. When such films are superimposed and no motion whatever is shown, a solid ankylosis can be assumed. Superimposed right and left lateral views are an additional safeguard. Forty-one of the present series were checked with motion x-rays; 33 of them (80.4 per cent) were completely solid, the films accurately superimposed and no motion could be demonstrated. In 6 (14.6) motion was demonstrable and failure of synostosis was accepted as present. Two cases (4.9 per cent) almost superimposed in the flexion and extension views and were probably solid, the slight change being accounted for by rotation of the patient in taking the films. If these are included, solid union was obtained in 88 per cent of the series.

A Case of Rupture of a Congenital Discoid Cartilage. J. R. Belcher. Brit. J. Surg. **32:** 435–437, January 1945.

A case is recorded in which a tear in a congenital discoid cartilage of the left knee was demonstrated preoperatively by air arthrography according to the technic of Cullen and Chance (Brit. J. Surg. **30:** 241, 1943. Abst. in Radiology **41:** 413, 1943). The roentgenograms are reproduced.

Mechanical Accidents During Convulsion Therapy. Celso Pereira da Silva and Paulo Ferreira de Barros. Arq. assist. psicopat. estad. São Paulo **9:** 107–127, March–June 1944.

In a period of fifty-five months, 1,843 persons underwent convulsive therapy at the Juqueri Hospital, São Paulo, Brazil. Metrazol was used to induce the convulsion in 1,500 patients and "electroshock" in 343. Twelve of the patients receiving metrazol and 3 of the electrotherapy patients sustained fractures. In addition, there was a shoulder dislocation in a patient treated by metrazol. Only cases severe enough to call for roentgen examination are included. The accidents are attributed to weakness of skeletal structures, abnormality of muscular response, and defective restraint. All of the patients made good recoveries.

In the authors' opinion a pre-convulsion roentgenogram is not indicated, as the percentage of skeletal complications is low and contraindications so detected would not outweigh the psychiatric indications for treatment.

War Casualties from Prolonged Exposure to Wet and Cold. Russel H. Patterson and Fred M. Anderson. Surg., Gynec. & Obst. **80:** 1–11, January 1945.

This is a report of the authors' experiences with injuries to the feet due to exposure during the Attu campaign, from May 11 to May 28, 1943. The patients were exposed from three to fourteen days to wet and cold, with artificial heat seldom available. A marked individual susceptibility was noted. Pain and hypesthesia were the main symptoms. The degree of tissue damage could not be correlated with the duration of exposure.

Twenty-one patients were treated by mechanical respiration produced by alternating positive and nega-

tive pressure on the thorax using the Terhaar respirator. This was considered superior to the pavex boot because it improved the deep venous and lymphatic return to the heart, thus improving capillary flow by producing a more favorable gradient between the arterioles and venules, and at the same time avoided undesirable local effects. The patients were also given oxygen in a further effort to relieve local tissue anoxia.

Among fifty-six patients with gangrene, three with negative anaerobic cultures showed multiple circumscribed rarefied areas in the soft tissues of the feet. These were considered to be due to separation and restriction of dry gangrenous tissue rather than gas-forming organisms. Changes due to gas gangrene came on more suddenly and were accompanied by toxic symptoms. All patients in whom gas bacillus infection was suspected received sulfa drugs, penicillin, or both, and also prophylactic x-ray treatment.

X-ray examination in most cases showed decalcification of nearly all the bones of the feet except where complete deep necrosis with loss of blood supply occurred and the bones appeared dense and white.

In 2 patients venous complications developed, and 2 had a recurrence of symptoms after five to nine weeks. Amputations were done five to nine weeks after injury. All patients retained a broad moist infected area at the site of demarcation. All granulating areas were prepared early for skin grafting with saline. Pathologic examination of the amputated parts revealed thrombosis and recanalization of blood vessels and total demyelinization of nerves at the level of demarcation.

In a majority of patients a foot deformity developed, usually a claw foot with varying degrees of pes planus. The great toe was pulled downward into plantar deformity and the intervals between all of the toes were increased, probably due to the greater damage to the intrinsic foot muscles. Deformity reached its height at four to six weeks and then tended to subside but 6 of 11 men with moderate tissue damage had persistent deformity after eight to ten months.

FRANK P. BROOKS, M.D.

Studies on Diseases of Muscle: Progressive Muscular Dystrophy: Clinical Review of Forty Cases. Robert E. Shank, Helena Gilder, and Charles L. Hoagland. Arch. Neurol. & Psychiat. **52:** 431–442, December 1944.

A clinical study of 40 patients with progressive muscular dystrophy is presented with reference to sex, age, and racial incidence. A discussion of the hereditary nature of the disease, its clinical course, and common physical signs is given. Roentgenograms are said to show streaking of the soft tissues of the affected muscles, demineralization of bones, and delay in ossification. Metabolic studies on some of the patients —rate of urinary excretion of creatine and creatinine, creatin tolerance, basal metabolic rate, intravenous dextrose tolerance, and nitrogen and phosphorus balance—are compared with normals.

ROBERT S. MACINTYRE, M.D.
(University of Michigan)

GYNECOLOGY AND OBSTETRICS

Future of Radiology in Obstetrics. J. Blair Hartley. Brit. J. Radiol. **17:** 241–246, August 1944.

The author first lists and discusses those types of investigation in which radiology may be expected to yield reasonably accurate information. These are: (1) demonstration of fetal parts (at 16 weeks or over); (2) estimation of fetal maturity; (3) demonstration of fetal death; (4) presentation and position of fetus; (5) demonstration of bony pelvis (shape and inclination of inlet; birth canal; outlet); (6) pelvimetry; (7) size and shape of uterus; (8) detection of fetal deformities and grosser developmental defects; (9) pyelography (size, function, defects, etc., of the maternal urinary tract). He then considers those types of examination in which normally a high degree of accuracy may be forthcoming, but in which it cannot be guaranteed, either because of complications or because there remain certain features still undemonstrable by any known technic. The list includes (1) early detection of the fetus; (2) estimation of disproportion (in spite of cephalometry and pelvimetry); (3) diagnosis of extra-uterine gestation; (4) diagnosis of complicating tumors; (5) cause of non-descent of fetal head into the pelvic inlet; (6) demonstration of placental site; (7) diagnosis of post-maturity; (8) detection of minor fetal defects and deformities.

Among future developments which are desirable are a radiopaque medium for placentography, some method for outlining tumors, a method of determining sex, more knowledge about the role of heredity in skeletal defects, more knowledge about the mechanism of labor, and the estimation and significance of molding.

The latter part of the paper is devoted to a plan for obstetrical research as a part of a national health program for Great Britain. SYDNEY J. HAWLEY, M.D.

THE GENITO-URINARY SYSTEM

Radiologic Aspect of the Urologic Problem. Robert A. Arens. J. A. M. A. **126:** 605–607, Nov. 4, 1944.

Tersely, with the justifiable assurance of one who has had long and valuable experience, the author summarizes the precautions to be observed, the essential features of good technic to be employed, and the results to be expected when x-ray methods are utilized in the study of the urinary tract.

FRED JENNER HODGES, M.D.
(University of Michigan)

Congenital Solitary Kidney: Case Reports and Consideration of Military Significance. Thomas F. Conroy and John H. Walker. J. Urol. **53:** 4–10, January 1945.

The authors believe that congenital solitary kidney is a fairly common anomaly, with an incidence of approximately 1 in 1,000. Its recognition is usually incidental to examination for some other condition. The authors quote from Dourmashkin and Light (Am. J. Surg. **50:** 348, 1940) the essential criteria for a correct diagnosis: "(1) Absence of the renal silhouette on the abdominal flat film. (2) Roentgenological evidence of renal enlargement and possible asymmetry of the psoas shadows. (3) Absence of opaque media on the agenetic side on excretory urography. (4) Absence of the ureteral orifice on one side after repeated cystoscopic examination in an otherwise normally appearing bladder. (5) Absence of indigo carmine elimination on the affected side." A sixth and corroborative criterion is the presence of an associated abnormality of the genital tract. Such abnormalities are more frequent and of greater clinical significance in the female.

In spite of these very definite criteria, mistakes in diagnosis are possible. Renal ischemia resulting from shock may cause temporary loss of renal function, and

excretory urography after severe trauma may lead to erroneous conclusions.

Two cases are reported in young men. In the first, urinary obstruction developed as a complication of sulfadiazine therapy for gonorrheal urethritis, and the ensuing cystoscopic examination failed to disclose any ureteral orifice on the left side. A flat plate of the abdomen showed a large left renal shadow but none on the right. The right psoas shadow was vague in outline and slightly wider than the left. Excretory urograms showed rapid filling and good concentration of the contrast medium in the left kidney, but no trace of dye on the right. Cystoscopy was repeated, and again no right ureteral orifice was discovered.

The second patient was hospitalized because of urinary symptoms found to be due to a chronic prostatitis. As in the first case, cystoscopy revealed the absence of a right ureteral orifice, and subsequent examinations confirmed the diagnosis of solitary kidney.

The authors emphasize the importance of verifying the presence of two adequately functioning kidneys before undertaking any surgical procedure upon the upper urinary tract. It is fully granted that an atrophic or markedly hypoplastic kidney may be diagnosed as agenesis, and that the final proof may be obtained only at operation or necropsy, but the important point is that only one functioning renal mass is present.

For patients with a congenital solitary kidney discovered incidentally, the prognosis is good, though the life expectancy is slightly below the average. Where the solitary organ is normal, the anomaly is considered to be neither an indication for rejection nor an adequate cause for discharge from military service.

R. E. BOOTH, M.D.

Malignant Renal Neoplasms: Clinical and Pathologic Study. Benjamin S. Abeshouse and Tobias Weinberg. Arch. Surg. **50:** 46–55, January 1945.

A study of 63 consecutive cases of malignant renal tumor was made to evaluate diagnostic methods and prognosis. In 53 cases the diagnosis was confirmed by operation, in 10 by necropsy. Forty-eight tumors were hypernephromas, 6 adenocarcinomas, 3 Wilms' tumors, 5 transitional-cell carcinomas, and 1 a squamous carcinoma. For the hypernephromas, data on metastatic spread were available in 13: the lungs were involved in 7, the bones and liver in 6 each, the regional nodes in 5, the spleen in 4, the adrenals in 3, the opposite kidney, the heart, and the brain in 2 each, and the seminal vesicles in 1. Local recurrence at the operative site was noted twice. Associated independent diseases were present in 21 cases; cardiac and other renal conditions were the most common. There were 5 cases of associated renal calculi. Hypernephromas were most common in the sixth and seventh decades; Wilms' tumors, in young persons.

The most common initial symptom was hematuria, the next pain, and the least common a mass. The time lapse from initial symptom to treatment varied from one month to seven years. Loss of weight, fever, symptomatic varicocele (Guyon's sign), and other symptoms were noted occasionally. Most patients had a slight or moderate anemia.

Diagnostic procedures of value, in addition to history and physical examination, were urinalysis, test of renal function, cystoscopy, and roentgen examination. While a plain film or intravenous pyelogram may give valuable information, the authors prefer retrograde pyelograms. These were made in all but 7 cases, in which an undiagnosed neoplasm was discovered at necropsy. Deformity or obliteration of the renal pelvis was usually present; calcification in the tumor was present in 8 cases and calculi in 5. The pyelograms were of assistance in establishing the diagnosis in 41 of the 56 cases. In 18 cases an incorrect diagnosis was made, but in 5 of these the neoplasm occurred in addition to other correctly diagnosed disease.

The authors state: "The only hope for the cure of renal neoplasms lies in early and complete removal ...." They accordingly operated in 53 of their cases; there were 4 postoperative deaths. In only 2 cases of hypernephroma was postoperative x-ray therapy employed, with no apparent benefit. In 2 cases of Wilms' tumor preoperative and postoperative irradiation were used; although the tumor shrank materially, a fatal outcome ensued within two years.

An analysis of the survivals in 34 patients with hypernephroma is given [the reason for excluding the other 14 is not stated]. Seven, or 20 per cent, lived five years or more; 5, or 14 per cent, ten years or more, and 2, or 5 per cent, fifteen years or more. This statistical summary is rather too condensed for clarity. A theoretical discussion of the factors influencing prognosis mentions the nature and duration of the symptoms, the condition of the patient, the type, size, and mobility of the tumor, the presence of thrombi in the renal vein, metastases, surgical treatment, and radiation therapy. There did not seem to be any relation to (Broders) grade of malignancy in this series.

The authors conclude that surgical intervention is justifiable in every case of suspected renal neoplasm despite the relatively low survival rate. Early diagnosis and operation increase the chance of cure.

LEWIS G. JACOBS, M.D.

Bilateral Renal Carcinoma. Howard G. Hanley. Brit. J. Surg. **32:** 399–402, January 1945.

There are about 9 recorded cases of bilateral renal carcinoma in the literature. In all but one instance the tumors were "hypernephroid" carcinomas or Grawitz tumors, the exception being a bilateral papillary carcinoma of the renal pelvis.

The author adds a case in a man seventy-three years old who gave a history of hematuria of three weeks' duration and loss of weight. There was a palpable mass in the right loin, which clinically appeared to be a large renal tumor. Intravenous pyelography showed no excretion from the right kidney and poor visualization of the left kidney. Cystoscopy revealed blood coming from the right ureteral orifice and clear urine from the left. A left retrograde pyelogram, showed complete amputation of the upper calices, the appearance being characteristic of a neoplasm or cyst. A week later a retrograde pyelogram of the right side failed to show any filling of the calices. A diagnosis of bilateral renal carcinoma was made. There was no evidence of metastases in the chest or skeleton. The serum phosphatase was: alkaline, 8.2 units per 100 ml., acid, 2.4 units per 100 ml.

Postmortem examination confirmed the diagnosis and revealed small secondary deposits on the parietal pleura. There was no evidence of growth extending along the renal veins. Sections from both kidneys showed typical hypernephroma tissue.

MAX CLIMAN, M.D.

THE BLOOD VESSELS

Method for Visualizing the Blood Vessels of Nerves and Other Tissues. Joseph Epstein. Anat. Rec. **89:** 65–69, May 1944.

In roentgenography of the fine vascular structure of an organ, the injection mass employed must fill and sharply define the vessels in a uniform manner. The author has found that a mixture of red lead in glue yields more satisfactory results than the commonly used preparations such as barium sulfate in gelatin, barium sulfate in agar, red lead in gelatin, and red lead in agar. The injected arteries can also be studied after the specimen has been cleared by the Spalteholz technic. This method, at first used to study the blood vessels of the sciatic nerve in dogs, has subsequently proved useful in defining the vascular supply of other tissues. The technic of preparing and injecting the medium and of taking the roentgenograms is described.

TECHNIC

Volume Localisation of Deep-Seated Tumours by Means of Tomography. E. M. Ungar, G. Spiegler, and D. W. Smithers. Brit. J. Radiol. **17:** 235–238, August 1944.

The growing use of volume doses makes the knowledge of the volume of a tumor and its localization imperative. This is best determined by tomography whenever the tumor may be visualized. It is particularly useful in tumors of the nasal sinuses, pharynx, larynx, lungs, fundus of the stomach, and the bladder.

For treatment purposes it is necessary to know the exact size. It is therefore necessary to know the exact depth at which the tomogram is made. This is accomplished by using a scale beside the patient, made of wax with opaque numerals indicating the depth at centimeter intervals. With this information and the target-film distance, correction can be made for distortion at any level. SYDNEY J. HAWLEY, M.D.

RADIOTHERAPY

Team Work in the Treatment of Cancer. The Mackenzie Davidson Lecture. H. S. Souttar. Brit. J. Radiol. **17:** 229–234, August 1944.

After a brief tribute to Sir James Mackenzie Davidson, one of the pioneers of British radiology, the author considers how best the resources of medicine may be organized for the treatment of cancer. The surgeon was the first to make a scientific attack on the disease. With the advent of x-rays and radium, the physicist opened up new prospects of cure, and recently the chemist has entered the field with stilbestrol and other preparations. The future rests with team work on the part of all these. While there will be no sharp boundaries defining the limits within which the activities of each worker must be confined, there must necessarily be spheres in which each is predominant. The attitude should be how much can each specialist contribute; not how much can he extend the value of his specialty.

The surgeon should establish the diagnosis, with the aid of biopsy whenever possible, and determine the extent of the tumor and the stage which it has reached, as well as forming a clear idea of the possibility and dangers of surgical removal. In therapy, some fields are notably the province of surgery, as cancer of the stomach and cancer of the colon; others belong to the radiologist, as cancer of the cervix. In still other cases the field is not well defined. It is here that team work will yield the best results. In some cases the surgeon can be of assistance to the radiologist by exposing the tumor or by removing residuals after treatment is completed.

Both the surgeon and the radiologist are indebted to the physicist, and he should be included to insure a good team, as should a biological chemist.

SYDNEY J. HAWLEY, M.D.

On Neglects from Patients and Doctors as to Symptoms and Diagnosis in Uterine Cancer. Lars Edling. Acta radiol. **24:** 45–54, Feb. 28, 1943. (In English.)

A critical survey of the cases of cancer of the uterine cervix seen at King Gustav V's Jubilee Clinic in Lund from 1927 to 1936 (414 cases with a 5-year cure of 26.2 per cent) shows that, at the original admission to the clinic, this disease is generally much more advanced than one would suppose from the history as given by the patients. In most cases this is due to their own lack of attention to their symptoms, usually as a result of indifference or ignorance. Not seldom, however, the doctor consulted is to blame for a false diagnosis or for failure to make a thorough examination. The blame lay here in 9 per cent of the series reported.

The author has grouped his material according to the time elapsed from the onset of cancer symptoms until the first medical consultation. He gives a detailed account of the special symptoms accompanying the different stages of the disease, as well as his impressions regarding the influence of the mentioned "neglects" on the result of x-ray treatment.

MAX SGALITZER, M.D.

"Supervoltage" Roentgen Installation in the Antoni van Leeuwenhoekhuis: Preliminary Clinical Results. D. den Hoed. Acta radiol. **24:** 82–88, Feb. 28, 1943. (In English.)

This is the fifth of a series of communications on the supervoltage [850 kv.] roentgen installation in the Antoni van Leeuwenhoekhuis, Amsterdam. The earlier papers, which dealt with the construction of the apparatus and physical and biological observations made with it (Acta radiol. **21:** 62, 583, 591, 1940; **23:** 565, 1942), are briefly summarized. Here the author records the first year's clinical experience, though he recognizes that after so short an interval—two and a half years—no final conclusions can be drawn. Results, however, were encouraging in some groups of patients, especially those with far-advanced cancer of the uterine cervix. Of 23 patients with cervical carcinoma regarded as incurable, 5 were "provisionally cured" (one and a half to two and a half years). Favorable palliative effects were obtained in other cases and reactions were moderate. MAX SGALITZER, M.D.

An Evaluation of Radiation in the Treatment of Carcinoma of the Corpus Uteri. James A. Corscaden. J. A. M. A. **126:** 1134–1138, Dec. 30, 1944.

The author presents an evaluation of the role of radiation in the treatment of carcinoma of the corpus uteri. The data for this analysis are largely derived

from reports in the literature, but some new observations based on his own experience are included. Considering only "operable" cases, the author presents evidence to show that with adequate doses of radium alone (intrauterine application), about 50 per cent five-year survivals may be expected. In the same type of case, surgery (total hysterectomy and bilateral salpingo-oophorectomy) without irradiation should produce somewhere near 60 per cent five-year survivals. It is the author's belief that the existing evidence justifies the expectation of 80 per cent five-year survivals in "operable" cases when the combination of preoperative x-ray and radium therapy, in adequate dosage, is followed by total hysterectomy.

ROBERT S. MACINTYRE
(University of Michigan)

Embryonal Tumor of the Sympathetic Nervous System: Report of Two Cases. Eric Selander. Acta radiol. **24:** 1–12, Feb. 28, 1943. (In English.)

Embryonal tumors of the sympathetic nervous system are rare malignant growths. They occur usually in children and metastasize early to bones, lymph nodes, and liver.

They arise from the common mother cells of the sympathetic ganglion cells and the chromaffin system, namely the sympathogonia, which in size and appearance are similar to lymphocytes, or they may be derived from cells which already show some differentiation. They usually occur in the ganglionated cord or the adrenal medulla.

An early diagnosis is difficult or impossible, and metastases are often the first clinically demonstrable lesions. Microscopic diagnosis of the tumor is also difficult, since its cells may often be mistaken for those of a small-cell sarcoma.

Both primary tumor and metastases are very sensitive to x-rays. The therapeutic effect is temporary, however, as in most cases the treatment will not be started until metastases have already spread over the body. MAX SGALITZER, M.D.

Radiotherapy in Osteoclastoma. Gwen Hilton. Lancet **1:** 110–112, Jan. 27, 1945.

Some authorities believe that osteoclastomas are of two roentgenologic types—the trabeculated and the osteolytic. Others regard the osteolytic type as only a more advanced form of the trabeculated. Three cases of the osteolytic stage or type are here presented, illustrating the difficulty of differential diagnosis. Two of the tumors were in the lower end of the femur, and one in the lower end of the radius. These are common sites for osteoclastomas of either type, and both the epiphysis and metaphysis are usually involved. Two of the cases showed the periosteal lipping generally considered pathognomonic of sarcoma. A biopsy was done in one of these cases, however, showing osteoclastoma and proving that lipping may be seen in such tumors also. While both sarcoma and osteoclastoma may show a central destructive lesion with a peripheral osteogenesis (periosteal lipping), the character of the tumor margin on the shaft side often differs. In a sarcoma the adjacent bone has an irregular appearance, which has been described as moth-eaten; whereas in osteoclastoma it may be foam-like, or the density of the shaft may gradually diminish toward the tumor area, or there may be a faint clear-cut trabeculation. When biopsy is impossible, the response of the neoplasm to irradiation may clarify the diagnosis. About twelve weeks after treatment of an osteoclastoma (as demonstrated in the author's cases), roentgenograms show early calcification. This recalcification proceeds and trabeculation reappears in the rarefied area. The trabeculae are, however, less clear-cut than in an untreated case, and the loculi between the strands are somewhat hazy. In sarcoma and in metastatic deposits, recalcification does not usually show honeycomb formation.

Satisfactory results with roentgen therapy were obtained in all three of the author's cases of osteolytic osteoclastoma. Cases of the trabeculated type have shown an equally good response, with no recurrence. Roentgenograms are reproduced.

Air Absorption Corrections for Soft X Rays. C. E. Eddy and J. L. Farrant. Brit. J. Radiol. **17:** 278–279, September 1944.

Absorption by air introduces an appreciable error in the measurement of x-ray dosage with soft radiation. The amount of this error was determined by various methods and is presented in a curve which shows the greatest error to be about 3 per cent at the h.v.l. of 0.5 mm. Al (50 to 60 kv.) to less than 0.5 per cent for 6.0 mm. Al (140 kv.). SYDNEY J. HAWLEY, M.D.

Dr. W. C. Röntgen